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The Copper Market. LAST week we alluded to the troubles that had come upon the French copper syndicate, and this week we may record the utter failure of their attempt to "corner" the copper market. For a time their chance of making money seemed good, and many industries, including the electrical, felt the pinch of higher prices for an article so necessary; but now there is every likelihood that rates will rule for a long time on a fair and normal basis. The syndicate have lost enormous sums of money, but they are not pitied any more than one pities highwaymen who calling on peaceable travelers to stand and deliver, are forthwith shot down.

Mr. Leo Daft. THOSE who are concerned in the development of electric power in this country will be interested in the portrait and biographical sketch which we present this week of Mr. Leo Daft, a pioneer in this great department of electrical industry. While the application of electricity to the transmission of power has already been so enormous in America, only a beginning has been made, and we may well believe that Mr. Daft still hopes to add to his laurels. At the present time he is concentrating his energies upon work on the elevated roads of New York city. As we stated last week, having operated successfully from Fifty-third to Fourteenth street on the Ninth avenue road, he now proposes to go down as far as Rector street, using the conductor which we then illustrated. Such work as this is of the highest importance, and we hope soon to see the day when the elevated roads will adopt electricity from one end to the other.

From Windsor to Pekin. IT is announced that Queen Victoria intends to have the electric light substituted for gas and candles at Windsor Castle, and at the same time news comes that an electric light plant is to be put in the palace of the Emperor of China at Pekin. Evidently England does not propose to be left behind by China in the adoption of the latest novelties of modern comfort and civilization. But when the rulers of these effete monarchies are thus rousing themselves, is it not time that something was done here in the same way with the stuffy old White House, which just now smells strongly of peppermint because President Harrison has been suspicious of the plumbing?

Gas and Electricity. THE figures which we quote this week from the *Progressive Age* as to the gas companies that have gone into the business of electric lighting, in this country, are not a little striking. It would appear that the tendency of the gas companies to promote the newer industry has not fallen off, but is gaining strength. As will be seen, a large percentage of the American gas companies are already supplying the light that was once despised and fought; and we believe that by process of purchase of old electric light plants, combinations with their electric rivals, and new investments, it will not be long before the majority of the gas companies are actively interested in the still young industry. When such a man as General Hickenlooper, who was wont to attack the electric light with all the eloquence and advertising space he could command, is willing to admit that the light, after all, is a good thing, and is even ready to help it along, it is clear that we have to face new conditions. Perhaps this change of attitude on the part of the gas companies has come a little quicker than some of the local electric light companies relish; but it was inevitable and was undoubtedly hastened by the advocacy of our excellent contemporary from whom we quote, and other journals connected with the gas industry. This early advocacy was evidence of a foresight that deserves praise.

Candle Power and Luminosity. ONE of the best papers which has been presented before the American Institute of Electrical Engineers is unquestionably that of Prof. E. L. Nichols, in which the efficiency of methods of artificial illumination is discussed in the most comprehensive and exhaustive manner. In this paper is brought out the fact, which has long been deemed a fault, that our measurements of illuminating powers are very crude; and Prof. Nichols describes very fully in just what these defects consist. He thus develops the fact that candle power may not, and in the majority of cases does not, represent the light-giving value of an illuminant, and that the ordinary photometer is especially liable to give us false results in determining this quantity. Moreover, for a correct valuation the spectroscope must be brought into requisition. Taking up the question of efficiency, Prof. Nichols shows that in the average incandescent lamp, excepting the latest three watts per candle lamp, the light-giving efficiency is only 5 per cent. of the total energy radiated from the filament, the remainder being lost as heat. Another thing which would hardly have been expected is the demonstration that the superiority of the arc lamp in the matter of candle power per horse power is not nearly as great as has been heretofore supposed to be the case; so that although the arc lamp may, when measured in the best and most favorable position, develop six and seven times as much light per horse power as the incandescent lamp,—when their mean spherical intensities are compared,—the actual difference otherwise is far less and the ratio is reduced to only 2 to 1, in favor of the arc lamp. But fortunately, as Professor Nichols points out, arc lamps are usually placed in such a position as to bring their best light-giving value into practical effect. In order to avoid the difficulties which have been met with in the past in the measurement of the light-giving value of illuminants, Prof. Nichols suggests a change in the method of measurements so as to take account of the fact that, as stated, the candle-power of a lamp does not represent its light-giving value, and as for the incandescent lamp he would refer that to a standard which should take into account the temperature and the area of the radiating surface. The paper is full of suggestions and contains a large number of points which might be elaborated, and upon which we ought to hear more from Prof. Nichols in the future. It not only deserves to be added that the paper was greatly enjoyed, but that it was rather an "address," being delivered extemporaneously with all its immense detail of figures, etc.

Accumulator Patents. THE decision of Judge Coxe, in the accumulator case, which we give in full on other pages, is a most interesting document from more than one point of view. Aside from the effect which it may have on the commercial development of the storage battery, the decision itself contains so many points in patent law and upon the admission and weighing of testimony, that it is commended to the careful perusal of all interested in patent property and especially electrical patents. We are met with the fact that a patentee may frequently suffer as much from claiming too much as from claiming too little, from which it is evident that the most rigid search is necessary to prevent such errors, which may, indeed, in the majority of cases, be entirely unintentional and even commendable. The court, while acknowledging Mr. Faure as an inventor of undoubted genius, considers itself forced to limit his invention to the application of an active material in the specific form of a "paint, paste or cement," leaving any broader idea of the application of an active material generally, out of consideration. Again, the fourth claim of Mr. Faure's patent, in which the grouping of the plates in a series of cells with a non-porous partition between them is claimed, is held to be invalid as it shows no invention and does not come under the head of a new combination of old and well-known materials, but is held to be a combination which would occur to any one versed in the art. In the case of the two Swan patents, the judge has decided that they are both invalid. The first of these relating to the application of the active material to a perforated plate is decided to be void on account of an anticipation due to Prof. Eaton, of Brooklyn, whose testimony went to show that he had perforated lead plates for that purpose before the issuance of Swan's patent. And again, the second patent of Swan for the arrangement of such perforations in regular order is held by the judge to constitute no invention, for the reason that it would be a most likely thing for any one constructing such plates to so perforate them. We cannot, however, at all agree with Judge Coxe in his holding that when a patent has been granted for a plate containing rows of holes there can be nothing patentable in the shape of the holes, or that a patent for a device containing round holes will preclude a subsequent patent for the same device with square or triangular holes. He seems to have left out of consideration here forms, which, though representing the same cross-section, might differ in longitudinal section and for which quite a number of patents have been granted in the past, the important object of which is to more securely hold the active material in place. These to our mind present undoubtedly the elements of invention. The result of the decision on this particular patent shows stronger than ever the many hardships which inventors may be subject to when the work of others is brought out and made to bear as an anticipation, even though such experiments may not have resulted in practical success and probably never would have been successful. The opinion of the Court, though extending to a considerable length, is worthy of close study, and possesses additional interest from the fact that it is practically the first decision in this country on the accumulator patent question, and affects an industry destined soon to assume mighty proportions.

Electric Lighting by Gas Companies.*

In *Progressive Age* for Oct. 1, 1888, was published a list of gas companies operating electric lighting plants; in the present number we repeat the list, with the most complete additions and corrections it has been possible to obtain, down to the hour of going to press. The former list was far from being complete, notwithstanding every effort was made to have it so, and there are undoubtedly numerous omissions from the present one, though it is beyond question more nearly perfect than the other.

From the list published last October it appeared there were at that time 153 gas companies operating a total of 12,834 arc lights, of 13 different systems. The list now published shows a total of 266 companies, operating a total of 21,313 arc lights and 55,890 incandescents. The number of different systems represented is 21. The systems and number of lights of each in use by the companies represented in the list are as below. But it is pertinent to state here that some companies in the list have failed to furnish us either system or number of lights, others operating two, three or four different systems only the aggregate number of lights. Taking the figures as they stand they make this showing:

System.	Arc.	Inc.	Total.
Thomson-Houston	11,084	8,826	19,910
Brush	3,964		3,964
Westinghouse		27,710	27,710
Edison		10,256	10,256
American	1,813	2,875	4,688
United States	250	4,425	4,675
Schuyler	734		734
Ball	613		613
Western Electric	566	250	816
Indianapolis Jenney	794		794
Fort Wayne Jenney	185	750	935
Jenney (Ind. or Ft. Wayne not specified)	324		324
Van Depoele	285		285
Waterhouse	222		222
Heisler		500	500
Remington	159	300	459
Sperry	130		130
Excelsior	90		90
Hochhausen	60		60
Weston	30		30
Fuller	10		10
Total	21,313	55,890	77,203

Grand total of arc and incandescent lights, 77,203.

This exhibit is an evidence of the rapidly growing conviction on the part of gas companies that the proposition, which it is well understood *Progressive Age* was first to advance, that gas and electric light supply should be entered into by gas companies, is unquestionably correct, and it is safe to predict that a republication of the list six months hence will see it again doubled.

**Progressive Age*, March 15, 1889.

ELECTRICAL WORLD PORTRAITS.—IV.

LEO DAFT.

In these days, when electric power is at last receiving the attention and consideration that its importance demands, it becomes fitting to remember and to honor the men who have been the pioneers in this great department of electrical application. We all know that to give the history of the electric motor would take us back 50 years, but it is also not less the fact that the practical transmission of power electrically belongs to the present decade, and peculiarly to the later development of the electrical arts in America. In fact, it seemed, not so long ago, that the electric motor would be no further advanced in 1900 than it was in 1850, or even in 1870, and the growth that has now come, and in the midst of which we find ourselves with not a little bewilderment at its suddenness and rapidity, is due to the faith and persistence of but a few inventors and their associates.

No one, we believe, will venture to cavil at the prominence in our gallery, of Mr. Leo Daft, whose portrait is presented this week, and whose position in the field of electricity is the result of such long and patient devotion to the use of electricity as a motive power.

Leo Daft was born in Birmingham, England, in November, 1843. His father was a civil engineer, member of English Institution of Civil Engineers and connected at that time with the firm of Daft & Co., designers and builders of hot houses, conservatories and similar structures, of which his grandfather was the head. The firm was subsequently dissolved by mutual consent when Thomas B. Daft formed a connection with the celebrated firm of Charles Macintosh & Co. as consulting engineer, a position which he retained for several years. Afterwards he connected himself with the Irish Engineering Company as managing partner, and, during a residence of two years in Dublin, he planned and constructed the great Wexford bridge over the Wexford flats. Leo Daft was at this time being educated at the Liverpool Collegiate, which he left to accompany his father to London in the year 1858, where he entered his father's office as draughtsman and articled pupil, and at the same time attended the lectures of Dr. William Pole, F. R. S., then Professor at the London University. During this time he had many opportunities for special instruction from Dr. Pole, who was a frequent visitor at his father's house, and for whom he frequently made the drawings to illustrate lectures at the University. He was also a constant attendant at the weekly meetings of the Institution of Civil Engineers. He was also about this time profiting by the acquaintance and assistance of Cromwell Fleetwood Varley, the eminent electrician, just then engaged on his celebrated cable work at Woolwich and at Camden Town, and a frequent visitor at the house of Thomas B. Daft, as were also many prominent engineers of that time, including the unfortunate Frederick Window and his confrères.

About this time, Mr. C. W. Siemens rendered young Daft considerable assistance in the way of loaning electrical apparatus, etc., for experimental purposes, and his father was careful to provide philosophical apparatus of various kinds, especially electrical; and a suitable "experimental room" was also provided at the paternal residence, where electrical, photographic and general physical experiments, frequently of a character very much calculated to disturb the domestic arrangements, were constantly in progress.

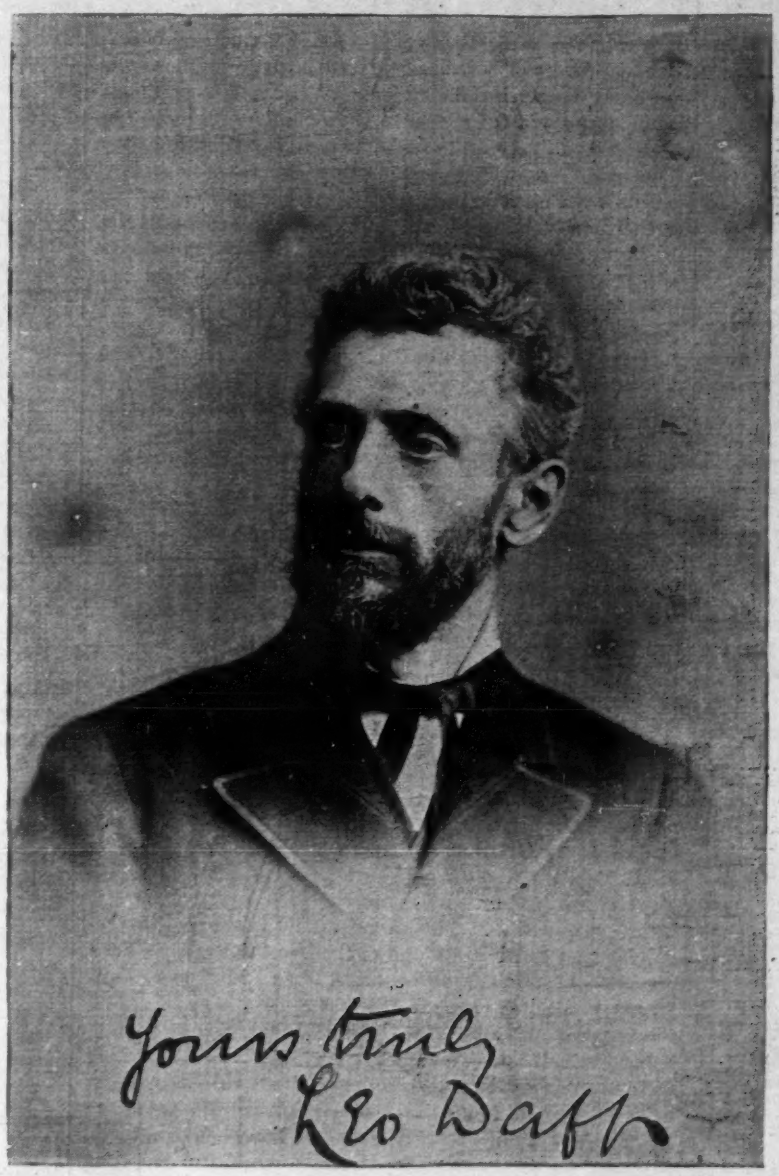
On the occasion of his twenty-first birthday, in 1864, the celebration of the event called together a large number of friends. A part of the entertainment consisted of a number of electrical experiments and the exhibition of an electric motor, operated from batteries loaned by Mr. C. W. Siemens. This motor was made to run a small lathe in the experimental room, and naturally excited a good deal of interested comment. Parts of this motor are still in existence, together with a number of small steam engines and similar apparatus built about the same time. At this period, Leo Daft's father was engaged in business as a consulting engineer, and was exploiting many inventions, twenty-eight of which are patented in the English Patent Office; and among the most important was a new method of constructing iron ships and sheathing them, which led to his election as an associate member of the Society of Naval Architects, before whom he read several papers on these subjects. The son, having now concluded to devote his whole time to electrical pursuits, was liberally provided with such apparatus as the practice of the day afforded, and acted for some time as electrician for his father, who had recently patented a new cable insulator, which was examined and favorably reported upon in a Blue Book by a government commission. The immediate cause of Leo Daft's coming to America was his employment in Liverpool as agent for his father in ship-building matters, where he came in contact with several enthusiastic Americans, and in a short time made up his mind to leave England. During his residence in Liverpool he read a paper, which the present writer has seen, before the Liverpool Polytechnic Society on the construction and sheathing of iron ships, having special reference to the galvanic effects of the different metals which were being used for that purpose.

In May, 1866, he sailed from Liverpool for New York, and after a short stay in this city and Philadelphia he went as far west as Louisville, Kentucky, where he was engaged for a short time as one of the assistant engineers on the Mount Vernon extension of the Louisville & Nashville Railroad, which was then being vigorously pushed. Upon the completion of this branch he returned to New York, after having visited Niagara Falls and other places, where he engaged in various minor enterprises. One of these was the manufacture of electric annunciators in New York and Philadelphia, which not proving remunerative was soon abandoned, and, as the electrical opportunities at that time were extremely limited, he turned his attention to photography in which he had become proficient as an amateur. He was engaged in this occupation for four or five years in the city of Troy, where he developed a large business, and where at one time he employed a considerable number of persons. While there he took large out-door photographs, one of which was 7 feet by 20 inches, and is now in his possession. For the first print of this negative, including as a background about 36 miles of the Mohawk Valley, he received no less a sum than $300.

On the death of his father, which occurred in 1879, he went to England to arrange some of his affairs, and on his return, about two months later, when great activity in electrical matters was developing, he abandoned the photographic business and betook himself with alacrity and enthusiasm to his old profession, being first connected with some gentlemen who formed the New York Electric Light Association, having a small factory in Centre street. This was soon merged into the Daft Electric Light Company. Some 18 months later, in 1881, the works, now at Marion, N. J., were removed to Greenville, N. J., where the company was almost immediately and exclusively devoted to the development of electric power, which first bore fruit in the installation of electric elevators in Spruce street, New York City; the establishment of the electric power station at Boston, followed by that of New York and other places; railroad experiments in 1883 at Saratoga; the building of the Baltimore electric road in 1884; the test of the original "Ben Franklin" on the New York elevated road in the same year, together with several railroad installations of more recent date, particularly that of the improved "Ben Franklin" made in the autumn and winter of 1888–89. It deserves mention here that in 1884 THE ELECTRICAL WORLD, desiring to make an exhibit at the Philadelphia Electrical Exhibition, determined to print its issue there by electricity. It was easier, however, to form the plan than to carry it out, but the Daft Company guaranteed a successful performance, and Mr. Daft himself took a hearty interest in the project. The generator, motor and press were duly set up, and within the five weeks of the exhibition 80,000 copies of the paper were printed from electrotypes, the type being set in New York. We have reason to know that this feat, besides attracting universal attention, gave, at a critical time, a direct and lasting impulse to the electric motor industry in this country.

As one example of the development of electric power, in New York alone, it will be sufficient to state, in the portion of Manhattan Island bounded by Chambers, Broad and Canal streets, about 700 h. p. is now daily distributed by the Daft system to some 200 consumers in quantities varying from ¼ to 30 h. p. All the apparatus, including motors, generators, switches, meters, etc., is of Mr. Daft's design, and we believe there is no other installation of the kind in that respect in the world. In other words, Mr. Daft is the only inventor so far who has taken up the problem of the distribution of power electrically and worked it out in the same manner as the distribution of current for lighting—providing and perfecting the necessary apparatus throughout.

Mr. Leo Daft, who married an American lady and has three children, resides at Plainfield, N. J., where his beautiful residence is lit by electricity supplied from his laboratory near by, and where electric power is also used as a "maid of all work." Of a reserved and studious nature, Mr. Daft has never gone much into public life, but prefers to spend his leisure in various researches and investigations. He is a member of the American Institute of Electrical Engineers.



LEO DAFT.

A Pointer on Dynamo Mishaps.

BY W. F. G.

In the operation of machinery of any kind mishaps are liable to occur at any moment; but if we are familiar with the signs and noises that sometimes precede such accidents they may frequently be avoided in time. I was forcibly reminded of this by a mishap which occurred in the station under my charge. The accident was rather unusual, inasmuch as it is the third of its kind to happen among almost seven hundred machines of this type put out.

The apparatus referred to is an alternating machine, and had run eleven months without any trouble whatever. A few nights prior to the breakdown we heard a very peculiar noise, which came direct from this machine and which may be compared to the noise made by a small jet of steam being suddenly turned loose and gradually diminishing to nothing. We could find nothing to cause this noise, and were considerably puzzled over its origin. But when the final breakdown came it was easily understood that the noise was caused by the breaking of a *few* strands of the small wires composing the bands, the loose ends raking over the magnet cores causing the noise described. But when the band proper gave way the result can be more easily imagined than described. The broken band being in the centre, it, of course, caught on the field-magnet cores, bunched up and stripped the armature of its coils. These coils wedged between armature and fields so firmly as to stop the engine before the throttle could be closed. The only parts of the machine thrown about were small pieces of cardboard and mica used in insulating the coils from the armature.

Had I removed the armature on first hearing the noise, I would probably have averted the accident, and I would suggest to readers of THE ELECTRICAL WORLD who operate any type of alternating machine to remove the armature and examine the same *at once* under similar circumstances, so as to avoid serious and expensive accidents.

(The matter touched upon in this article is interesting. We should like to know from some of our readers whether the defect in the machine should not have been discovered before the accident occurred. The hint given by "W. F. G." as to timely inspection would be pertinent under any conditions and with any apparatus.—EDS. E. W.)

The Efficiency of Methods of Artificial Illumination.[1]

BY EDWARD L. NICHOLS, PROFESSOR OF PHYSICS IN CORNELL UNIVERSITY.

Of human industries of the present day none perhaps, save those which have to do with providing the race with food, clothing, shelter and fuel, is more important to the cause of material wel-

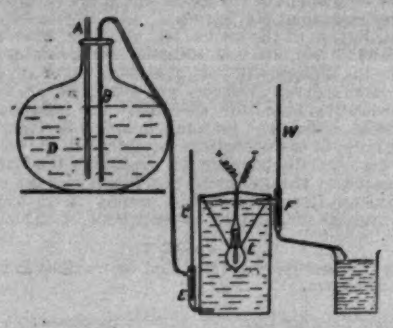


FIG. 1.—EFFICIENCY OF METHODS OF ILLUMINATION.

fare than that which deals with the production of artificial light, and he who seeks a means of measuring the material civilization reached by a nation might find an excellent criterion in the progress which it exhibits in the art of illumination.

The problem of comparing the various methods of artificial lighting which are in vogue at the present day is one of great interest, whether we view it from the commercial standpoint, taking the cost of production as our controlling factor, or from the broader basis of relative usefulness, cost being relegated to a secondary position, or, finally, from the purely scientific point of view. From whichever side we approach this question, we are led inevitably to the consideration of certain elements which are alike of scientific, utilitarian and commercial importance.

At first sight the attempt to determine the relative value of two sources of light would seem to be a simple matter. The number of factors, however, which enter into such a determination is surprisingly large, and many of them are of a character which makes it difficult to give them definite and complete expression. Of these the greater part are indeed commonly left out of account altogether, for the sake of simplicity, and we content ourselves with an antiquated and totally insufficient measure of our sources of illumination, which we call candle power. It is to these other elements which enter into the question of the character of artificial light—such, for instance, as have to do with its *quality*—but which are, as a rule, quite lost sight of, to which I would ask your attention this evening, together with a discussion of those which are commonly made use of in photometry. If, in so doing, I am led to speak of methods which belong to the realm of pure science, I trust that you will agree with me in thinking that the results are not unimportant even to those whose interest in the problem of the production of artificial light is purely utilitarian.

In the important question of the efficiency of a light-producing machine or process, the practice of to-day is very far from having reached that degree of exactness of expression which we demand in other cases of the transformation of energy. In electric lighting the energy expended is readily determined in absolute measure, or in that excellent practical unit, the *Watt*. In lieu of any attempt to express the useful energy obtained, however, we still content ourselves in practice with that most unscientific unit, the candle power, based upon a source of illumination which is particularly subject to fluctuations of intensity and color. Even as used in the Bunsen photometer the shortcomings of the standard candle are sufficiently apparent, but no one who has not attempted to study it by methods which make it possible to detect changes of color as well as of brightness, can fully appreciate its fickleness.

Such as it is, we do not moreover make the best of the standard candle as a basis of comparison of artificial lights. We speak of a 16-candle incandescent lamp, for instance, meaning oftentimes "mean spherical candle power" and then we compare it with a petroleum or gas flame, measured in the horizontal plane only, much to the disadvantage of the electric lamp. The study of the distribution of intensities in accordance with the very complete system devised for that purpose by the Franklin Institute Committee in 1884, affords an invaluable means of comparing the performance of various types of incandescent lamps; but the adoption of "mean spherical candle power" as obtained by that method, is, to say the least, misleading when it comes to the comparison of electric lamps with candles, oil or gas. It is to be hoped that when the present confusion of methods of measuring candle-power now existing in the electric lighting establishments in this country is supplanted by a recognized system, the fairer standard already established by law in England, viz., mean horizontal candle power, may be adopted. It is, however, in the comparison of arc and glow lamps that the latter are put at the greatest disadvantage. Here we pit the incandescent lamp, using mean spherical candle-power as our basis, against candle-power measured at the angle at which the arc light sends out the greater part of its rays. Indeed, in too many cases, it is not with the actual intensity even in this most favorable position with which we have to do, but with an estimated or "nominal" candle-power which the arc, in matter of fact, never approaches.

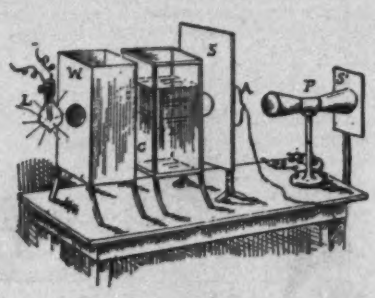


FIG. 2.

The electric arc stands quite alone, for the purposes to which it is adapted, and need fear no rivals. It does not need to be estimated upon any fictitious basis, and the continuance of the pernicious practice of ascribing to it powers of illumination which it does not possess must, in a great measure, be charged to the account of the standard candle; for with the best intentions in the world, the comparison of sources of light differing so widely in color as the candle and the electric arc, is nothing more than a rude approximation, leading by its very inaccuracy to the temptation of the grossest exaggeration.

There are fortunately better methods of estimating the efficiency of a lamp than that which is based upon candle power.

We may, for instance, determine the ratio of the energy of the light-giving radiation to that of the total radiation of the source of illumination. The efficiency of the incandescent lamp, according to this definition, has been recently determined by Mr. Ernest Merritt,[2] of the Physical Laboratory of Cornell University. Mr. Merritt followed two independent methods of investigation. In his first experiments the lamp was placed in a calorimeter constructed entirely of glass, Fig. 1, through which a constant flow of water was maintained. The temperature of the water upon entering and upon leaving the calorimeter was measured by means of the thermometers *E* and *F*. From this difference of temperature and the amount of water discharged in a given time, the heat absorbed by the calorimeter was calculated, proper corrections for loss of heat by radiations, etc., being applied. Now the water with which the calorimeter was filled is nearly transparent to the light-giving radiations from the lamp, and almost entirely opaque to the longer wave lengths which constitute the so-called heat spectrum. To have assumed it to be entirely so, would, however, have involved very considerable errors, and the diathermancy of the calorimeter on the one hand and its power of absorbing the luminous wave-lengths on the other, were accordingly carefully determined by methods long since elaborated and made use of by Melloni and by his distinguished English follower, Professor Tyndall. By applying these and other necessary corrections, we are able to calculate very accurately in watts, the non-luminous radiation from the lamp. The ratio of the total radiation, obtained either by submerging the lamp in a metallic calorimeter or by direct computation from the current and electro-motive force gives the actual efficiency of the lamp considered as a light-making machine. The result is not a gratifying one, when we compare this process with most others in which energy is transformed. The efficiency of the best types of incandescent lamps, previous to the introduction of the recent 3 watts per candle lamps now in successful operation, which would doubtless make a somewhat better showing, was found to be rather under, than over 5 per cent. at normal candle-power; the values ranging from 5 per cent. to

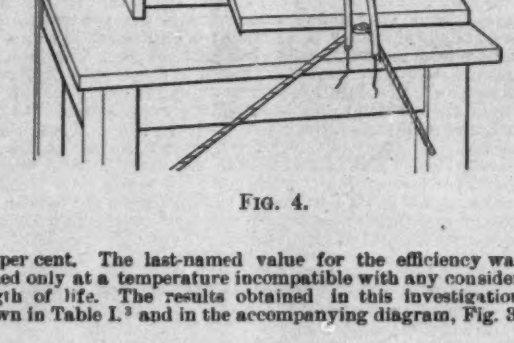


FIG. 4.

6.5 per cent. The last-named value for the efficiency was attained only at a temperature incompatible with any considerable length of life. The results obtained in this investigation are shown in Table I.[3] and in the accompanying diagram, Fig. 3.

TABLE I.[4]

Lamp A. Edison.

E. M. F.	W	C. P.	L	L/W	L/C. P.
74.2	34.6	0.9	0.18	0.005	0.59
91.6	56.2	4.8	0.68	.012	0.14
97.3	64.6	7.3	1.13	.017	0.15
100.3	69.3	8.9	1.62	.023	0.18
107.6	81.6	14.6	2.97	.036	0.20
109.3	84.4	16.3	4.57	.054	0.28
124.1	115.4	38.2	7.46	.065	0.19

In this table *W* is the total energy, in watts; *L* the energy of the light, also measured in watts; and *C. P.* the candle-power.

The second method pursued by Mr. Merritt was intended rather as a check upon the results already obtained than in the expectation of gaining further data. The rays of the lamp were allowed to fall upon the face of a delicate thermopile placed at a distance of about 60 c. m. The thermopile was in circuit with a low resistance galvanometer of the well known "tripod pattern" of Sir William Thomson. The deflection of the galvanometer was taken as a measure of the total radiation, luminous and non-luminous, which fell upon the face of the pile. A cell containing a solution of alum was now interposed, and the reduction in the galvanometer noted. The arrangement of this apparatus is shown in Fig. 2.

An aqueous solution of alum fulfills much more nearly the desired condition of complete opacity to "dark heat" and complete transparency to the rays of the visible spectrum than any other substance, but a certain small percentage of the longer wave lengths will pass through such a bath, and a considerably larger percentage of light giving rays will be cut off by it. The proper corrections are, however, easily determinable, and when in this case they had been determined and applied, the ratio of total to luminous radiation was found to be in gratifying agreement with

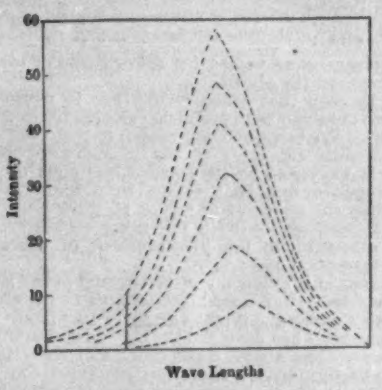


FIG. 3.

the efficiency obtained by the calorimetric method already described. See Table II.

TABLE II.

Lamp B.

An Edison 16 C. P. Lamp. Resistance = 249 ohms.

E. M. F.	W.	C. P.	L.	L/W	L/C. P.
63.0	25.4	0.3	0.42	0.016	1.61
74.6	37.8	1.0	0.77	.021	0.79
85.4	52.5	2.5	1.96	.037	0.78
99.0	72.2	6.3	4.30	.059	0.68
116.0	102.0	15.2	7.38	.072	0.49

Lamp C.

Weston 16 C. P. Cold resistance = 402 ohms.

E. M. F.	W.	C. P.	L.	L/W	L/C. P.
72.0	21.6	0.4	0.46	0.021	1.27
87.4	33.5	1.5	1.10	.033	0.76
102.0	47.8	4.4	2.09	.044	0.48
117.0	66.1	10.7	3.19	.048	0.30

Lamp D.

Weston 16 C. P., 70 volt. Resistance = 152 ohms.

E. M. F.	W.	C. P.	L.	L/W	L/C. P.
43.0	25.8	0.5	0.53	0.021	1.06
50.7	36.0	1.6	0.97	.027	0.62
60.5	52.0	5.2	2.03	.039	0.39
67.5	65.5	11.0	3.95	.060	0.36

Lamp E.

Bernstein 8 C. P. Resistance = 11.3 ohms.

E. M. F.	W.	C. P.	L.	L/W	L/C. P.
12.2	25.2	0.2	0.20	0.008	1.00
13.4	30.8	0.5	0.41	.013	0.84
15.0	40.4	1.3	0.75	.018	0.57
16.4	53.2	4.1	2.03	.038	0.50

It is interesting to compare these results with some obtained by still another method. Captain Abney and Colonel Festing in

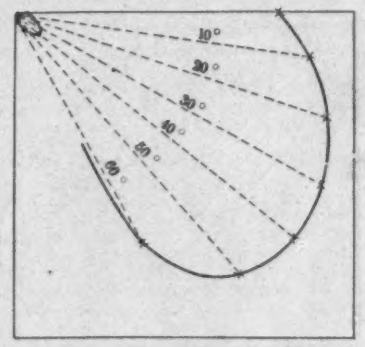


FIG. 5.

the Proceedings of the Royal Society have described a series of elaborate studies of the radiation of the incandescent lamp. The portion of their very important investigation which has a bearing upon the efficiency deals with the exploration of the spectrum of the lamp, under various degrees of incandescence, by means of an exceedingly sensitive thermopile. The energy of the visible spectrum of most sources of light is so minute that it has generally been deemed impracticable to measure it in this way. Captain Abney and his co-worker have, nevertheless, secured measurements covering not only the extensive regions of the so-called heat spectrum lying inside the red, but also the shorter wave lengths which constitute the visible spectrum. Their results are shown graphically in Fig. 3.

One of the British Electric Company's lamps was subjected to measurement in six different states of incandescence, corresponding to 33.6, 60.2, 93.8, 116.4, 130.8 and 150.5 watts respectively. The curves show the intensity of each wave length of the spectrum, when the above amounts of energy were expended in the filament, and the total area inclosed by each curve affords a relative measure of the total radiation of the lamps in the state of incandescence in question. I have added to this diagram, of which, in other respects, Fig. 3 is a faithful reproduction, the vertical line lying between scale-divisions 5 and 6 of their scale. This line marks the boundary between the visible and invisible spectrum. The entire area to the right of that line represents

[1] A paper read before the American Institute of Electrical Engineers, March 12, 1889.

[2] Ernest Merritt, *American Journal of Science*, vol. 37, p. 167.

[3] Dr. Blattner in an Inaugural Dissertation, published at the University of Zürich, gives similar values for the efficiency of the incandescent lamp. He finds, as the result of extended measurements with the glass calorimeter, that " * * * "at the normal temperature of incandescence, where the intensity lies in the neighborhood of 16 candles, the efficiency does not rise above 5 per cent. to 6 per cent."—Emil Blattner: *Der Optische Nutzeffect der Glühlampen*, Frauenfeld, 1886.

[4] Tables I. and II., and Figs. 1 and 2, are taken from Mr. Merrit's paper, already referred to.

the energy wasted in the lamp; the much smaller area to the left comprises the light-giving rays. The ratio of the entire area of each curve to that portion lying within the boundaries of the visible spectrum gives us the efficiency of the lamp for the state of incandescence produced by the expenditure of the number of watts for which the curve is drawn. This ratio increases from a very small value with the brightness of the lamp.

I have made approximate integrations of the areas embraced by the curves for 150.5 and 130.8 watts, respectively, for the purpose of comparing the efficiency thus calculated with the results obtained by Mr. Merritt. The ratios are:

Watts.	Efficiency.
150.5	5.55 per cent.
130.8	5.15 "

The corresponding values for lower states of incandescence are all smaller than the above.

It will be seen that these results are in complete agreement with those obtained with the glass calorimeter and by the method of Melloni. We have, indeed, reason to feel that our knowledge of the absolute efficiency of the incandescent lamp, in so far as it can be expressed by the ratio of luminous to total radiation is well grounded, and that we are in position to determine the light-giving efficiency of any type of glow-lamp in any condition of incandescence with the same certainty and exactness which is attainable in the measurement of other machines for the transformation of energy.

The average net efficiency of the incandescent lamps of to-day, for we may leave untouched for the present the efficiency of the processes by which the latent energy of fuel from which the current is generated has been converted into electrical energy, is rather below, than above, 5 per cent., and since the ratio of total radiation to light-giving radiation increases but slowly as the temperature of the radiating body rises, the efficiency is not likely to be increased in any very marked degree until we shall have learned how to suppress altogether these long wave lengths which yield us dark heat, and are able to limit the vibrations of our source of light to that brief octave which comprises the wave lengths to which alone the human retina responds.

Whether this great step is to be made by robbing the glow-worm and fire-fly of their secret, as has been suggested in a recent address by the Director of the Sibley College of Mechanical Engineering,[5] or by development along the lines sketched the other evening by Professor Brackett at the meeting of the Electric Club, or by the application of some principle as yet unconceived, we know not. Meantime, we have in the methods of artificial lighting of to-day abundant material for study and investigation.

The investigation of the efficiency of the arc light by the methods under consideration, is a much more difficult matter than the same determination in the case of the incandescent lamp. The radiating surface of the latter is very nearly of the same temperature throughout, and the ratio of total radiation to luminous radiation, obtained for the bundle of rays sent out in a single direction, gives us at once the measure of the efficiency. In the arc we have, however, a light-giving area of great brilliancy in the immediate neighborhood of the arc, and the temperature of the carbons falls with great rapidity from the maximum at the point and crater to regions which are at a red heat.

The entire light-giving area is included between the line surrounding the positive carbon, which is at red heat, and the corresponding line upon the negative carbon. Between these two lines we pass rapidly through regions, the light from which varies with the degree of incandescence by insensible gradations from that which a red hot surface is capable of emitting to that coming from carbon at the highest temperature which that substance can be made to assume. Now, the curve of distribution of candle-power taken in a vertical plane is, as we all know, a very peculiar one, and if we place our thermopile with alum cell interposed to measure the energy of the light-giving rays, the amount of radiation received upon the face of the pile will greatly depend upon the position in which the apparatus is set up. At an angle of 45 degrees, or 50 degrees below the horizontal plane, for instance, the amount indicated will be five or six times greater than in the horizontal plane. Now, the surface of total radiation is much larger than that from which the light-giving rays emanate. It includes, in addition to the incandescent surfaces near the arc, all those portions of the carbons which are heated, either by conduction or by the current.

The amount of heat radiated from regions which are below the red heat is very considerable, and forms an important factor in the determination of the efficiency. Were the distribution of total radiation in the vertical plane identical with that of the light giving rays, the measurement of their ratio with the axis of the thermopile in any plane which passes through the arc, would give us the efficiency of the lamp; but the curve of distribution of total radiation is not the same as that of candle power, and the ratio in question is a function of the plane which the axis of the pile makes with the horizon. It becomes necessary, therefore, to make an exploration of the entire zone through which the lamp sends out rays, determining the ratio of total to luminous radiation for each angle, and then to integrate the results. Such an investigation is now in progress under my direction, and Mr. H. Nakano, who is carrying on the experiments, has reached some exceedingly interesting results. The research will soon be ready for publication in its complete form, and it will afford us much more definite data concerning the radiations of the electric arc than we now possess. It will not be out of place even now to say

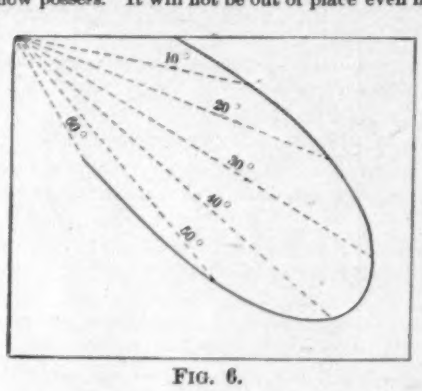


FIG. 6.

word concerning the method which is being employed, and the general character of the results already obtained.

The first measurements were made by the second method employed by Mr. Merritt, the thermopile in the horizontal plane. The lamp subjected to measurement was of the long-arc type, with 9 ampères of current and 45 volts. The efficiency in this plane was found to be surprisingly small. It was found, moreover, to vary in marked degree with the diameter of the carbons used, increasing as the diameter decreased to the point at which the carbons were rendered hot by the current, when, as might be expected, it fell off again.

The lamp was then mounted in a frame which also carried the thermopile and alum bath, and which was so constructed that measurements could be made at any desired angle. All necessary changes of angle could be made without varying the distance from the arc to the face of the pile, or the relation of the alum bath to the latter. By means of this apparatus, which is shown in Fig. 4, it has been found possible to determine the ratio of total to luminous radiation throughout the zone of radiation of the lamp, and to plot the curve of distribution of each.

Without entering into the details of an incompleted research, I may indicate the general character of the results by means of a diagram. The curves shown in Figs. 5 and 6 are those relating to a "long-arc" lamp with carbons .45 inch in diameter. They represent respectively the distribution of luminous and total radiation emanating from the lamp. The radii show the positions for which measurements were taken; distances measured along these lines from the origin to each curve give the relative intensities of light-giving and total heat energy in each position.

The curve of luminous radiation corresponds in form with that of candle power. The distribution of total radiation, however, differs widely from these and the ratio, $\frac{\text{luminous energy}}{\text{total energy}}$, is a function of the angle which the line of measurement makes with the horizontal plane. The values of the efficiency in the case in

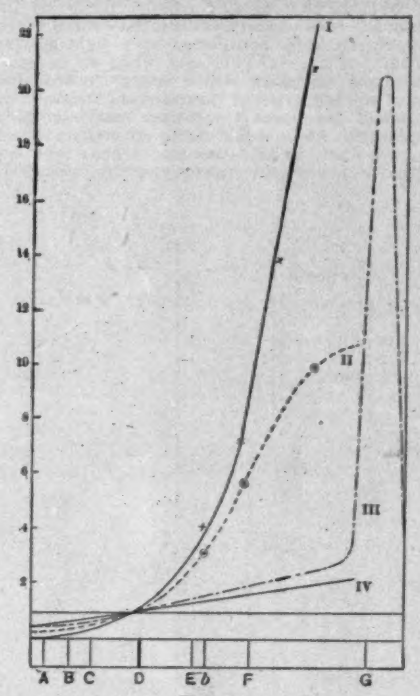


FIG. 8.

question for the various angles at which measurements were made, are given in Table III. They form the basis for the curve in Fig 6, which is the diagram of efficiencies of the arc light under the conditions of operation already stated.

TABLE III.

Efficiency of an arc lamp; after measurements by Mr. H. Nakano.

Angle.	Efficiency $= \frac{\text{Luminous radiation}}{\text{Total radiation}}$.
0°	.0548
10°	.0901
20°	.1228
30°	.1506
40°	.1552
50°	.1059
60°	.0676
63°	.0492

The integration of these values gives as the mean efficiency of the arc lamp in question, .104; or 10.4 per cent.

The ratio of the radii of two semi-circles, the areas of which equal the areas inclosed by the curves of luminous and total radiation, gives us a measure of the "mean spherical" efficiency of the lamp. This ratio in the case of the lamp to which these curves refer is very much smaller than the generally accepted values of the efficiency of arc lamps, expressed in terms of the candle-power per watt, would lead us to expect. The intensity of the arc is, however, seldom expressed in mean spherical candles, and there are few data relating to the candle-power of this source of light upon which to found satisfactory estimates. On the one hand we find it stated, doubtless correctly, that the mean light-producing efficiency of the eleven dynamos, tested at the International Health Exhibition, held in London in 1884, was 1,440 candles per horse-power,[6] while the glow lamps only yielded 175 candles, and it is with estimates similar to the above with which we have generally to satisfy ourselves in comparing arc and incandescent systems of illumination.

For the purpose of deciding whether the results of Nakano's method of determining the ratio of luminous to total radiation are compatible with our other sources of knowledge concerning the arc light we must make use of mean spherical candle-power as our basis of comparison.

Very careful measurements of the mean spherical candle-power of two arc-lamps of representative and successful commercial types were made in the physical laboratory of Cornell University,[7] following the method of the Franklin Institute Committee. Both of these lamps were rated at 2,000 candle-power. They were maintained by dynamos of the types for which they had been especially designed, working under normal conditions. One of the lamps gave a mean spherical candle-power of 295, when working in series with nine other lamps of the same construction. When placed in circuit alone, the candle-power rose to 348. The energy expended in the lamp in each case was 550 watts, and the efficiency accordingly 1.8 watts and 1.6 watts per candle.

The other lamp was found to reach 609 mean spherical candles at the cost of 601 watts. An inspection of the result obtained by the Franklin Institute Committee would lead us to regard these as extreme values, between which the performance of almost all arc light would lie, as a rule, nearer the lower than the upper of these limits. The efficiency of arc-lights, then, expressed in mean spherical candle power per watt is frequently as low as 1.5 times that of the incandescent lamp, and, rarely, three times as high. Now the mean efficiency of the arc lamp under discussion, *i. e.*, the ratio, $\frac{\text{luminous radiation}}{\text{total radiation}}$, according to the measurements of Mr. Nakano, is almost exactly 10 per cent. The efficiency of incandescent lamps, defined in the same way, according to Mr. Merritt, may, as we have seen, be taken at about 5 per cent. The ratio is 2:1 in favor of the arc lamp, which lies within the limits determined by comparison of candle-power and watts.

Small as these values for the efficiency of the electric light are, they show marked improvement over the efficiency determined in a similar manner for sources of illumination which depend upon the incandescence of carbon by direct combustion. More than a quarter of a century ago, Julius Thomsen[8] presented before a gathering of Swedish men of science, the results of an investigation of the energy consumed in the sperm candle, and in various oil and gas flames. His memoir bore the suggestive title of the Mechanical Equivalent of Light, and is one of the earliest contributions to our knowledge of the energy of luminous radiation.

The instruments employed in Thomsen's experiments were the thermopile and galvanometer, the indications of which were reduced to absolute measure by determination of the deflection produced by the radiation from a glass globe filled with hot water. The total loss of heat by radiation which this globe suffered was calculated from its rate of cooling, using Dulong and Petit's law. The water equivalent of the globe was 1,851 grains; its total loss of heat per minute at 50 degrees C. was 250 calories; its loss of heat by radiation at the above temperature, when the air of the room was at 17 degrees, was 102 calories per minute. Under these conditions the influence of the globe of water upon the thermopile placed at a given distance was observed. A luminous body having been substituted for the globe, its influence on the pile was likewise noted, and its total radiation in calories calculated by comparison of the deflections produced in the two cases.

For a sperm candle burning 8.2 grains per hour, the total radiation estimated by this method was 210 calories per minute. Other flames gave out quantities of heat nearly in proportion to their candle power, as will be seen by inspection of Table IV.

TABLE IV.

Calories per candle-power radiated by various flames, according to Julius Thomsen.

Source of illumination.	Candle-power.	Calories per candle.
Sperm candle	1.	210
Gas flame	1.2	201
Gas flame	7.7	199
Moderator lamp	8 6	199

The luminous energy was obtained by a method similar to that pursued by Merritt in the experiments already described. A bath containing a layer of water 20 c. m. in thickness was interposed between the lamp and the thermopile, and the indications of the galvanometer noted. The results were based upon the assumption that the cell absorbed 13 per cent. of the light and all of the dark rays. This estimate is doubtless faulty and may involve a reduction of several per cent. from the values given by Thomsen. His results, uncorrected, are as follows:

TABLE V.

Energy of luminous radiation of various flames in calories, according to Julius Thomsen.

Source.	Candle power.	Luminous energy per c. p.
Candles	1.	4.4 calories.
Moderator lamp	6.25	3.9 calories.
Moderator lamp	8.6	4.1 calories.
Gas	7.7	4.2 calories.
Gas	1.2	3.7 calories.

The energy of the light-giving rays per candle-power of light produced is then, according to Thomsen, very nearly the same for the flames of the candle, oil lamp and gas burner. This conclusion has been abundantly confirmed by spectro-photometric observations of the quality of the light which they emit. It appears, moreover, from these observations, of which I shall have occasion to speak at length presently, that the temperature of the incandescent particles in such flames agrees very closely indeed with that of an incandescent lamp, consuming 5 watts at 16 candle-power, being, as a rule, lower, rather than higher, than the latter; and the calculation of the energy of such a lamp in calories per minute, making use of the data furnished us by the investigation of Abney and Festing, or of Merritt, affords most satisfactory evidence of the accuracy of Thomsen's results. Let us take for example the case of an incandescent lamp in which 5 watts per candle-power are expended, and in which the ratio,

$$\frac{\text{Luminous radiation}}{\text{Total radiation}} = .05.$$

The energy converted into light in such a lamp is .25 watt. Now,

1 gramme-calorie $= 4.2 \times 10^7$ ergs.

1 watt $= 10^7$ ergs $= \frac{1}{4.2}$ gramme-calories per second.

.25 watt $= \frac{.25 \times 60}{4.2}$ gramme-calories per minute and the heat equivalent of the luminous energy is 3.6 gramme-calories per minute.

This value is somewhat smaller than those given by Thomsen in the preceding table, but proper corrections for the diathermancy of the water bath used in his experiments and for the difference in standards of candle power—the light given by his sperm candle being slightly in excess of the legal standard of the present day—will bring the two into excellent agreement.

The entire energy developed by the chemical reactions occurring in these flames per candle-power of light produced were, however, about 1,400 calories in the case of candle and oil lamps, and 4,100 calories in the case of gas, so that the gross efficiency would be respectively 0.3 per cent. and 0.1 per cent. The average ratio of total radiation reaching the thermopile to luminous radiation is about .2 per cent., but this ratio cannot be

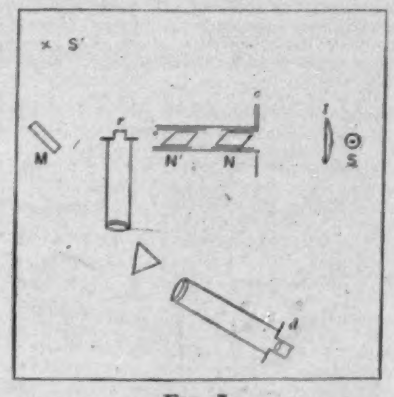


FIG. 7.

considered in the same light as that obtained in the case of the incandescent lamp, since a gas or oil flame is in reality a column of heated vapor containing particles of unconsumed carbon, which reaches far above the luminous region, sending out dark rays from its upper and cooler portions, which do not reach the face of the thermo-pile at all. The relation which the total radiation of this heated column bears to the heat dissipated by convection cannot be determined, and the determination of total radiation from the light-giving portions alone is of little value. It is only in the matter of gross efficiency, therefore, that we can institute a comparison between electric lamps and the older methods of illumination, and the gross efficiency of the former depends upon the efficiency of production of electric current. Under conditions, such that 10 per cent. of the total energy of the fuel consumed is converted into electricity,—conditions which are, I believe, rarely attained by our present methods,—the gross efficiency of an incandescent lamp, of which the net efficiency, determined by the methods which I have already described, is 5 per cent., would be 0.5 per cent; a value which is five times greater than that of a lamp burning the kind of gas used by Thomsen, and which stands in the ratio of 5 : 3 (or, probably, rather more than that) to the gross efficiency of an oil flame. These flames must, of necessity, vary very widely with the quality of the fuel consumed, and with the condition under which combustion is maintained.

If we apply a similar method of computation to the values given by Mr. Preece in his recent address at the Bath meeting of

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[5] "The second of these greatest of inventors is he who will teach us the source of the beautiful soft-beaming light of the firefly and the glow-worm, and will show us how to produce this singular illuminant, and to apply it with success practically and commercially. This wonderful light, free from heat and from consequent loss of energy, is nature's substitute for the crude and extravagantly wasteful lights of which we have, through so many years, been foolishly boasting. The dynamo-electrical engineer has nearly solved this problem. Let us hope that it may be soon fully solved, and by one of those among our own colleagues who are now so earnestly working in this field, and that we may all live to see him steal the glow-worm's light, and to see the approaching days of Vril predicted so long ago by Lord Lytton."—ROBERT H. THURSTON—*Transactions of the American Society of Mechanical Engineers*, 1881, p. 22.

[6] Julius Maier: Arc and Glow Lamps, p. 52.

[7] *The Photometry of Arc Lights.* Thesis by Benjamin W. Snow, 1885. MS. in the Library of Cornell University.

[8] Julius Thomsen: Das Mechanische Æquivalent des Lichtes; *Poggendorff's Annalen, Bd.* 125, p. 348.

the British Association for the Advancement of Science[9], assuming that the conditions under which each illuminant is consumed are such that the temperature of the incandescent carbon equals that which is maintained in the filament of an incandescent lamp at 5 watts per candle, with a net efficiency, as before, of 5 per cent., a set of conditions which can be attained in practice only in the most perfectly constructed oil and gas lamps, and which are fulfilled in many of the best of our incandescent lamps of today, we obtain the following results:

TABLE VI.

Gross efficiency of various illuminants deduced from the values given by Preece. The heat equivalent of a candle is assumed to be 3.6 gramme calories per minute.

Illuminant.	Watts per candle. (Preece.)	Gram'e-calories per minute per candle.	Luminous radiation. Total radiation = gross efficiency.
Tallow.....	124	1770.	.00203
Wax.....	94	1340.	.00268
Sperm.....	86	1230.	.00293
Mineral oil.....	80	1143.	.00315
Vegetable oil....	57	815.	.00442
Coal gas.....	68	971.	.00317
Cannel gas.....	48	685.	.00521

In considering these values it should be borne in mind that coal-gas is a fuel which has been obtained by the previous expenditure of considerable energy. Were we to take as our basis the consumption of coal necessary to the production of a candle-power of light, instead of the heat of the combustion within the gas flame itself, the values for the efficiency of coal-gas as an illuminant would be very considerably reduced.

We have already seen that there are excellent experimental grounds for the statement that the gross efficiency of the incandescent lamp is about .005, and that of the arc lamp about .01, under the assumption of the waste of 90 per cent. of the total energy of the fuel in the various processes leading to the production of the current, and that the latter figures, small as they are, are considerably in excess of the gross efficiency of candles, oil or gas. We are in possession, moreover, of the means of expressing exactly the degree of superiority which the electric light possesses over those illuminants in the important matter of the heating effect upon the surrounding atmosphere. Gas and oil flames deliver in the neighborhood of 1,000 gramme-calories of heat per minute to the room for each candle-power, of 3.6 gramme-calories of luminous radiation. An incandescent lamp of 5 per cent. net efficiency delivers only 72 gramme-calories per candle power.

The net efficiency of the incandescent lamp may be raised somewhat by increasing the temperature of the carbon filament, and, indeed, it has already been somewhat raised by the introduction of the new "3 watt" lamps. These lamps have been excluded from this discussion because we have as yet no complete data with reference to them, and because it seemed desirable, aside from that, to institute comparisons between sources of illumination in which the degree of incandescence was the same, and for all of which, consequently, candle-power had the same meaning.

When we raise the temperature of our source of light, however, we introduce changes, of which the methods thus far considered take no cognizance.

In increasing the degree of incandescence, the ratio of luminous energy to total energy of radiation is slowly increased, and at the same time the relative brightness of the various rays which constitute the visible spectrum changes. In a word, *the quality of* the light changes, and we are confronted by important variations which cannot be expressed in candle-power.

The investigation of these changes in composition, upon which color depends, involves the study of the visible spectrum of the source of light and the comparison of its intensity, wave length for wave length, with the spectrum of some properly chosen standard. The instrument necessary to this work is the spectrophotometer, by means of which the spectra of the two lights to be compared are brought together in the field of view, one above another, like wave lengths everywhere in the same vertical line. The measurements consist in bringing the two spectra to the same intensity in each of the regions selected for observation successively, and in determining the amount by which it is necessary in each case to reduce the intensity of the brighter. A variety of devices have been made use of for varying the brightness of the spectra, and the standards of comparison adopted by different observers have included the candle, the petroleum flame, the gas flame, and the incandescent lamp, maintained at a constant voltage. Thus W. H. Pickering[10] obtained the necessary range of intensities by placing the lamp under inspection upon a sliding carriage and varying its distance from the slit of the spectroscope. His standard of comparison was a gas flame. H. C. Vogel[11] used as his standard a petroleum flame. Crova,[12] who brought the intensities of the two spectra to equality by means of a polarizing device, adopted the moderator lamp as a standard. Otto Schumann, in his study of the incandescent lamp, made use of a "benzine" candle. The intervention of a revolving disc with open and closed sectors and of wedges of smoked glass have also been applied to the regulation of the intensity, and the method of varying the width of the slit itself, a device due to Vierordt, has been found to give good results, where the range of intensities was inconsiderable.

The methods of presenting the results of this class of measurement have differed as widely as the methods of observation and the choice of standards; but it is possible wherever the data are properly given and the character of the standard is known, to reduce them all to a common basis of comparison. When thus reduced these measurements are found to agree in all essential particulars, and they afford us very definite knowledge of the character of the light emitted by the sources of illumination to which the spectro-photometer has been applied.

Fig. 7 shows the form of the spectro-photometer recently used by Mr. W. S. Franklin and myself in an extended series of observations upon artificial sources of illumination and in the comparison of their spectra with that of daylight.

To the slit of a one prism spectroscope are attached a set of total reflection prisms, *r*, by means of which rays may be introduced into the upper and lower halves of the slit, these rays coming respectively from sources of illumination placed to the right

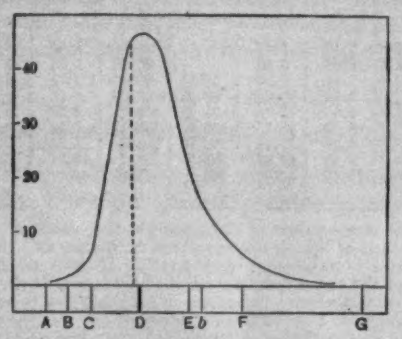


FIG. 11.

and left-hand in a line at right angles to the axis of the collimator tube. The standard of illumination, which is an incandescent lamp *S*, maintained at 16 candles, is placed at the observer's right hand.

Its rays having been rendered parallel by means of a condensing lense *l*, pass through a pair of Nicol's prisms *N* and *N'*, the first of which is free to revolve and enters the upper half of the slit. The intensity of the spectrum of this lamp can be reduced at will by the rotation of the first Nicol, and its brightness is calculated from the angle between the planes of polarization of the two Nicols. To the left of the slit is mounted a block of magnesium carbonate, its face vertical and forming an angle of 45 degrees with the axis of collimation of the spectroscope. The rays of the source of light to be investigated *S'*, which is placed at a convenient distance, fall upon the magnesium carbonate, and it is such of the diffusely reflected rays from the latter as reach the total reflection prisms, and thus enter the lower half of the slit, which form the second spectrum. The object gained by the interposition of this white surface is an important one. All artificial light, except that from an incandescent lamp, emanate from glowing materials varying greatly in temperature, and the spectrum obtained directly from the source is always that due to some particular portion of the luminous body under investigation, to the exclusion of the remainder, and differs more or less in character from that of the source taken as a whole.

The spectrum of rays reflected from the face of the magnesium carbonate, however, contains in proper proportions the light

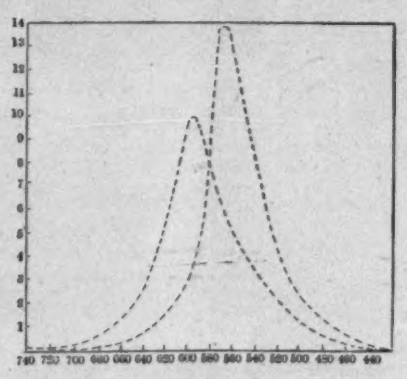


FIG. 13.

from all portions of the source, and one of the chief sources of error to which spectrophotometric work is subject, is thus eliminated.

The investigations made with this instrument, which have been described in a paper read before the American Association,[13] included the measurement of candle flames, and of various petroleum and gas lamps, also of the lime light, the incandescent lamp under a wide range of conditions, of the electric arc and of daylight by clear and by clouded sky. The results obtained illustrate the precise character of those differences in composition to the bearing of which, upon the study of the efficiency of artificial illumination, I desire to call your attention.

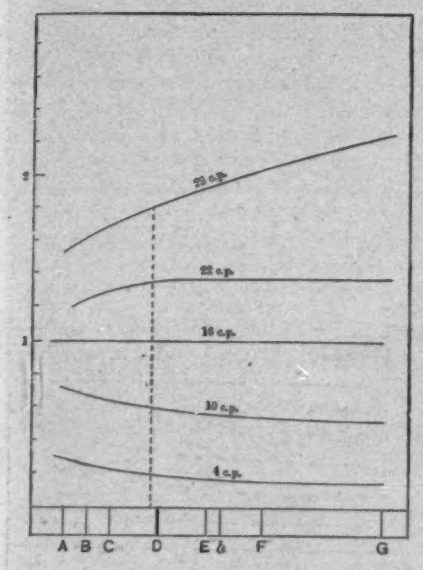
In the first place it was found that the light of the candle, and of oil and gas flames, although subject to considerable fluctuations from variations of the condition under which combustion occurs, differ but slightly in quality from each other and from that of incandescent lamps maintained at normal candle power. The incandescent material in all is carbon, and it is a significant fact that the average temperature of incandescence is nearly the same in all luminous flames, and that the highest temperature, until very recently at any rate, at which it has been found practicable to maintain the carbon filament of the glow-lamp, is very nearly that at which the same material exists under the most favorable conditions in oil and gas flames. Hence it is that the radiant energy per candle-power, as has been shown by Julius Thomsen, is nearly the same for all these flames.

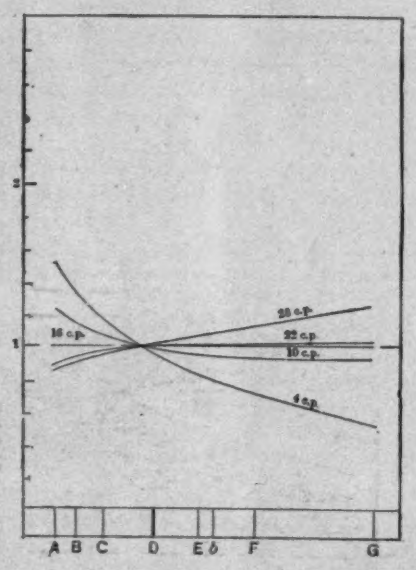
Passing to other sources of illumination, such as the lime light and the electric arc, we find the entire portion of the spectrum lying beyond the yellow increasing more rapidly, regions of longer wave-length than the yellow increasing less rapidly than the candle-power; the rate of increase growing steadily as the wave length diminishes from the red to the violet end of the spectrum. Fig. 8 shows the results of comparisons of the spectra of the lime light, electric arc, and of daylight, by clear and by unclouded sky, with that of an incandescent lamp maintained at its normal candle-power. This lamp which was chosen as a standard of comparison, was an Edison 16 candle, 100 volt lamp. Its light was precisely similar to that of a "Board of Trade" argand gas burner, showing the same relative brilliancy throughout the whole of the visible spectrum. The measurements were made with the spectrophotometer just described (see Fig. 7), the light in every case falling upon the block of magnesium carbonate, and entering the slit of the spectroscope after reflection from the face of the latter. For purpose of comparison the brightness of the standard incandescent lamp has been taken as unity throughout the spectrum. If we make a diagram in which abscissæ are wave-lengths, and ordinates, intensities, referred to that of the standard as unity, the curve for this lamp will be a straight horizontal line, with ordinate = 1.

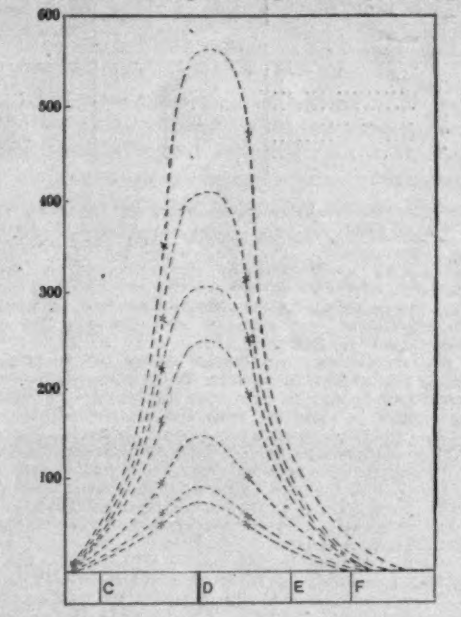
All other spectra are reduced to the same brightness in the region of the *D* line of Fraunhofer, and their brightness in other regions, referred to that of the corresponding wave length in the spectrum of the standard, is shown by means of curves.

Observations were made in ten regions of the spectrum, equidistant as to wave-length, and embracing the whole of the visible spectrum. It will be seen by reference to the fig. 8 that the lime light, curve IV., is relatively much stronger in the violet and much weaker in the red than the standard. In the arc light, curve III., this increase of intensity toward the violet is even more marked, but its variation in quality from the lime light is by no means so great, as its exceedingly brilliant, bluish-white appearance to the eye would lead us to expect. The source of that appearance and of the very high actinic value of the arc is found, however, in the presence of an exceedingly bright band in the extreme violet. Here the relative intensity of the arc light spectrum rises abruptly about 3 to 20 times that of the incandescent lamp.

Measurements were made upon a long-arc lamp with ⅛-inch carbons, with 10 ampères and 50 volts and a short-arc lamp with a 20 ampère current. The character of the light was found to be almost identical excepting in this light band in the neighborhood of the *G* line, which is much more prominent in the long-arc lamp. The character of the light was found to be much the same at all angles below the horizontal plane.







FIGS. 9, 10 AND 12.—EFFICIENCY OF METHODS OF ARTIFICIAL ILLUMINATION.

The only other spectrophotometric measurements of the electric arc with which I am acquainted, have been made upon the Foucault regulator, a lamp with carbons of small diameter. Fairly concordant determinations of the distribution of intensities in the spectrum of this lamp by W. H. Pickering[14], H. C. Vogel[15], and Crova [16], show that the light of this lamp is decidedly bluer than that of the lamps with large carbons in vogue at the present day; the spectrum of the former being about five times as rich in the violet as that of gas or oil flames. Mr. Nakano's results, of which mention has already been made, indicate marked increase in the efficiency of the arc lamp, as the diameter of the carbons is decreased; and since increase of efficiency arises from a higher average degree of incandescence, we should expect just such an increment in the shorter wave-lengths as shows itself in the case of the Foucault regulator.

Finally, in the case of daylight we find the intensity of the shorter wave-lengths exceedingly great as compared with that of any artificial source of illumination. If the spectrum of daylight be brought into comparison with that of an incandescent lamp, and the two be reduced to the same intensity in the yellow, the extreme red of the daylight spectrum will be so *dim* in comparison with that of the lamp as to render measurements difficult. In the violet the discrepancy will be just as marked, the sun's spectrum being relatively of enormous brilliancy. Curve I., Fig. 8, shows the result of such a measurement of the daylight spectrum, taken just after noon upon a cloudless summer day.

Vogel has given data of a determination in which the preponderance in the violet was even more marked, the relative intensity of daylight for the region corresponding to wave-length, 4,260 (just beyond the *G* line), being 100 : 1 for spectra which were equally bright in the neighborhood of the *D* line.

Ordinarily, there is considerable absorption of the blue and violet by moisture in the atmosphere, and a measurement of daylight under a densely clouded sky gave Curve II. Even under these conditions, with the violet reduced to about one-tenth of the value which it possesses in clear weather, daylight is very much bluer than any artificial light. The light emitted by burning magnesium approaches more nearly to it than any other, being, according to Pickering, considerably stronger throughout the blue and violet than the light from the Foucault arc-lamp. Its color, however, is not reinforced by a violet band like that in the spectrum of the electric arc, a region which by its extraordinary brightness has marked influence upon the color of the light.

These variations depend upon temperature primarily, and they may be studied to the best advantage in the spectrum of the incandescent lamp. The radiating surface of such a lamp is at a nearly constant temperature throughout, and it may be given a very considerable range in the matter of incandescence, involving variations in color and total intensity, which are under complete control.

[9] Preece: Address before Section A, meeting of the B. A. at Bath, 1888. Nature, Vol. 38, p. 496.

[10] W. H. Pickering, *Proceedings* of the American Academy of Arts and Sciences, Vol. 15, 1880.

[11] H. C. Vogel, *Berliner Monatsberichte*, 1880, p. 801.

[12] A. Crova, *Comptes Rendus*, 87, 1878, p. 322.

[13] Edward L. Nichols and W. S. Franklin. A Spectrophotometric Comparison of Artificial Sources of Illumination. Paper read before Section B.; A. A. A. S. at the Cleveland meeting, August, 1888.

[14] W. H. Pickering, *l. c.* [15] H. C. Vogel, *l. c.* [16] A. Crova, *l. c.*

An Edison lamp, similar to that which had been used as a standard in our previous measurements, was subjected to spectro-photometric analysis by Mr. Franklin and myself, at 4 candles, 10 candles, 16 candles, 22 candles and 28 candles, successively. The results obtained are shown in Fig. 9.

The spectrum of the lamp at 16 candles is taken as of unit brightness throughout and the other curves show the amount of light of each wave-length emitted by the lamp in the above-mentioned states of incandescence. Intensities, in every case, are referred to the light of corresponding wave-length, given by the same lamp at 16 candles, as unity.

At the red end of the spectrum the intensity increases more slowly than candle-power, at the violet end more rapidly. There exists an intermediate wave-length for which the brightness is proportional to the candle-power. The vertical line in the diagram shows the portion of the spectrum for which this holds true, a point in the yellow at wave-length 6,000.

If we suppose the same measurements executed upon a set of lamps in every respect similar to the one in question, excepting that their radiating surfaces are of such size that they give 16 candles, as indicated by the Bunsen photometer when the degree of incandescence corresponds respectively to that at which the lamp actually measured emitted at 4, 10, 16, 22 and 28 candles, there would result a set of curves of the same general character as those in Fig. 12. At wave-length 6,000 these curves would have a common value, and they would serve to indicate both the quantity and quality of the variation of the carbon filament, as a function of the incandescence, candle-power remaining constant. The form of these curves is shown in Fig. 10. They afford us data for discussion of the candle as a standard of illumination which could not be obtained in any other way. They show the relative distribution of energy in the spectrum of five lamps, which, according to the indications of the Bunsen photometer, are of equal brightness, but which differ both in the quality and in the total energy of their luminous radiation. Their efficiency expressed in terms of the candle-power produced per watt expressed in the lamp, rises rapidly as the incandescence increases. For lamps of the type upon which these measurements were made, for instance, the relative efficiency referred in each case to that of the lamp, the incandescence of which corresponds to that of an Edison lamp at 16 candles, is given in the column headed, $\frac{\text{Candle-power}}{\text{Watts.}}$, in table VII.

TABLE VII.

State of incandescence equivalent to that of an Edison 16-candle lamp giving—	Relative efficiency referred to that of a 16-candle lamp as unity.	
	Candle power / Watts.	Luminous radiat'n / Total radiation.
(1) 4 candles	.394	.211
(2) 10 "	.729	.632
(3) 16 "	1.000	1.000
(4) 22 "	1.218	1.368
(5) 28 "	1.391	1.589

If, however, we retain as the measure of efficiency, the ratio $\frac{\text{luminous radiation}}{\text{total radiation}}$, we can deduce from these curves values coinciding with those reached by the method of the thermopile and alum cell. To this end we must know the above-mentioned ratio for some one candle power and the number of watts necessary to the production of each state of incandescence for which the computation is to be made.

The relative efficiency can then be calculated from the areas inclosed by the respective curves. Were the candle-power proportional to the energy of luminous radiation, the values thus obtained would be identical with the relative efficiency determined from the relation of candle-power to watts. The relative efficiency thus compiled (see Table VII.) does not coincide with that obtained from the ratio of watts to candle-power, however, for the reason that the various rays which make up the visible spectrum do not enter into the production of candle-power in proportion to their energy. The most important wave lengths, so far as light-giving power is concerned, are those which form the yellow of the spectrum, and the relative luminosity falls off rapidly both toward the red and the violet. The longer wave lengths have, however, much more influence upon candle-power than the more refrangible rays, as will be seen by an inspection of the curves, the relative falling off of the red end of the spectrum being compensated by larger and larger accessions in the blue and violet as the state of incandescence increases.

Luminosity is the factor which we must take into account in seeking a complete expression for the efficiency of any source of illumination, and the method to be pursued in the determination of the luminosity must depend upon the use to which the light is to be applied. If we estimate light by its power of bringing out the colors of natural objects, the value which we place upon the blue and violet rays must be very different from that which would be ascribed to them if we consider merely its power of illumination as applied to black and white. In a picture gallery, for instance, or upon the stage, the value of an illuminant increases with the temperature of the incandescent material, out of all proportion to the candle-power, whereas candle-power affords an excellent measure of the light to be used in a reading room.

A number of determinations of the luminosity of artificial light have been made. In the earliest of these by Vierordt,[17] the amount of white light which may be mixed with each color of the spectrum, without producing an appreciable change of tint, was taken as the measure of the luminosity of that color. The result is shown graphically in Fig. 11. The curve indicates the light-giving power of each wave length, estimated in the above manner. The source of light experimented upon was a petroleum flame. The vertical line indicates the region of the spectrum within which—according to the measurements of the quality of light of the incandescent lamp already described—the increase in the brightness of the spectrum is proportional to the candle-power. This region corresponds very nearly with that of maximum luminosity of the spectrum.

The luminosity of the blue and violet rays is so very small that in the production of *candle-power* the influence of the very rapid growth of this end of the spectrum with increasing temperature of the lamp is scarcely appreciable. If we estimate the light-giving value of the different portions of the spectrum by means of the facility with which we can distinguish black characters upon a white ground, the importance of the more refrangible rays is still farther diminished. Thus Macé de Lepinay and Nicati[18] have shown that if yellow and blue light, estimated to be of equal brightness by photometric means, are of such intensity that one can clearly distinguish a printed page when illuminated by the yellow, the same page will be entirely illegible when the blue light alone falls upon it. These observers conclude, indeed, that "the mere distinguishing of objects is due almost exclusively to the illumination produced by the less refrangible half of the normal spectrum;" so that at equal brilliancy "the superiority of yellow sources of light (luminous gas flames, incandescent lamps) over sources richer in blue rays (light of the electric arc) is incontestible." "The only real advantage," they add, "upon the side of the light from the electric arc is when one desires to rehabilitate objects more nearly in the hues which they present in the light of day." This single advantage is one which it is impossible to take due account of, numerically, in an estimate of the efficiency of artificial illumination. It is nevertheless a most important factor in determining the adaptability of a light to nearly all the purposes of every-day life.

Otto Schumann,[19] to whom we owe a most exhaustive study of the light of the incandescent lamp, has determined the luminosity of several types of such lamps at various stages of incandescence. His results, in so far as they apply to a 16-candle Edison lamp, are given in Table VIII.

TABLE VIII.

Luminosity of an Edison lamp at various stages of incandescence, according to Otto Schumann.

Ampères.	Volts.	Watts.	Luminosity of various regions of the spectrum.						
			Red λ = 676	Orange λ 656	Yellow λ 615	Green λ 557	Blue λ 487	Indigo λ 464	Violet λ 429
0.625	87.3	54.6	1.18	4.64	.....	20.14	0.64	0.11	.....
.678	90.4	61.3	1.68	6.66	.....	30.35	1.05	0 20	.....
.727	94.7	68.8	2.24	9.34	53.11	50.05	1.71	0.34	.....
.748	97.4	72.9	2.59	10.92	63.28	62.23	2.28	0.47	.....
.823	105.0	86.4	4.06	17.14	99 22	104.3	4.09	0.88	.....
.944	112.9	106.7	6.97	28.85	163.0	189.1	7.88	1.75	.....
1.009	117.6	118.6	8.74	37.14	222.6	255.7	11.62	2.71	0.42
1.035	120.4	124.7	9.36	41.67	263.3	317.7	16.04	3.79	0.69
1.099	124.5	136.4	11.43	52.36	345.2	472.2	26.24	6.53	1.04

I have made these values of Schumann's the basis of a set of curves, by means of which the variation in luminosity, with total energy in watts, is exhibited, see Fig. 12. It will be seen that the position of the maximum moves slightly towards the violet as the brightness of the lamp increases. This tendency is very slight within the range of temperatures reached by the incandescent lamp. In the arc light we should find the displacement most marked, but in the case of sunlight, in which, as we have seen, the shorter wave lengths are in such preponderance, the movement of the maximum is inconsiderable. The curves shown in Fig. 13 are taken from the investigation by Crova, who has determined the distribution of luminosities in the spectrum of sunlight and of the flame of a petroleum lamp. The maximum in sunlight is at $\lambda = 582$, that of the petroleum $\lambda = 592$. Nearly all sources of illumination will be found to have a maximum lying between these two wave lengths.

A comparison of the total luminosity of the incandescent lamp with its candle-power shows that the former increases with the energy of the lamp more rapidly than the latter, although the discrepancy is not so marked as in the comparison of efficency of candle-power with that of luminous radiation.

The following table, obtained by the summation of the luminosity curves, shows the relation between candle-power and total luminosity, in the case of the lamp studied by Schumann:

TABLE IX

Candle-power and total luminosity of the incandescent lamp.

Watts.	Candle-power.	Total luminosity.
54.6	.....	4.11
61.3	.....	6.31
68.8	10.12	10.20
72.9	12.05	12.58
86.4	18.80	20.64
106.7	31.60	36.80
118.6	41.44	49.77
124.7	50.16	60.85
136.4	64.15	.....

Plainly then, candle-power does not afford a measure either of the light-giving energy or of the luminosity of a source of illumination. When used in the comparison of sources which differ in temperature, the indications of the photometer always yield us relatively too low a value for the intensity of the lamp of higher incandescence. In the case of candles vs. gas, or of either of these in comparison with the incandescent lamp at normal temperature, the error is not important, but between the candle and the "16 candle" lamp maintained at 50 candle power, the discrepancy amounts to 10 per cent. For the electric arc the ratio of candle-power to total luminosity is very nearly 4 : 5, and in the case of daylight it is about 4 : 6.

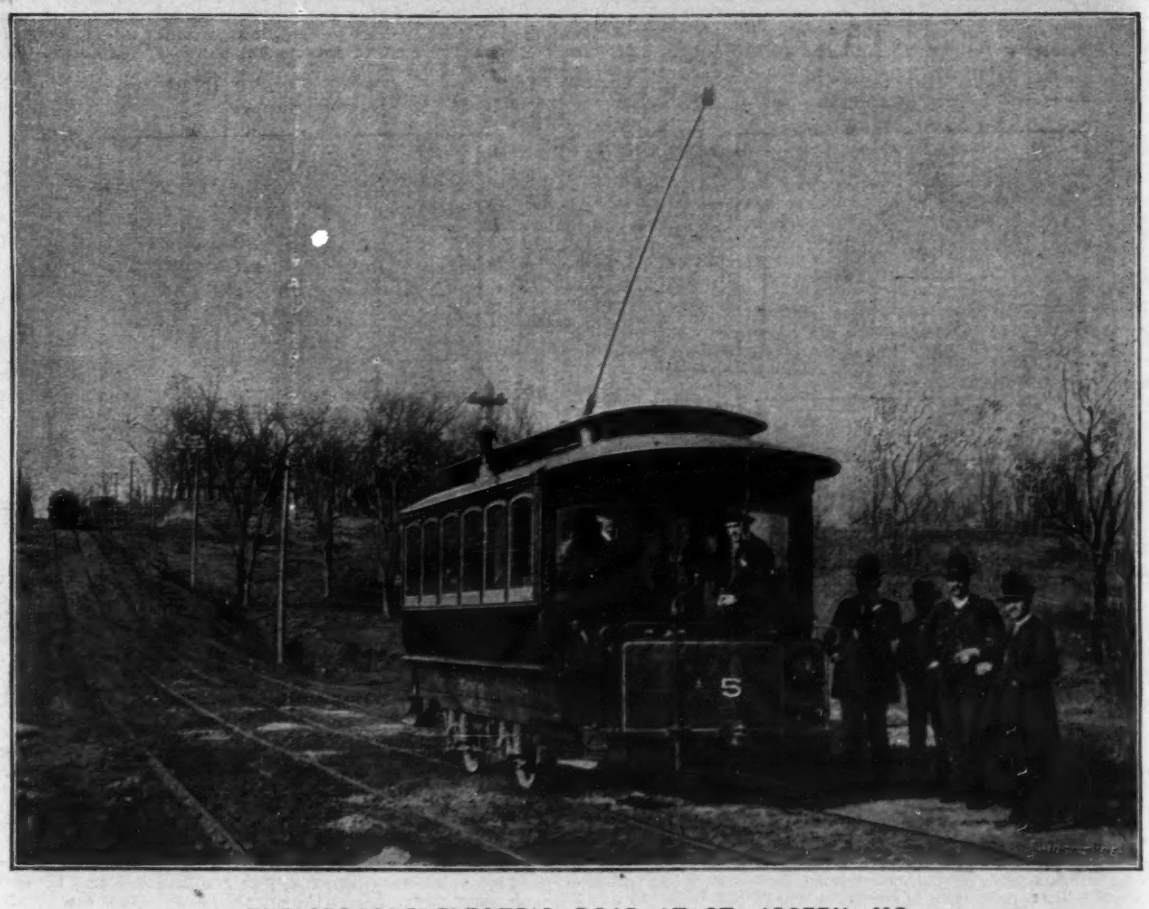
In arc-light photometry, candle-power is already a well-nigh meaningless term. Would it not be well to abandon it altogether in favor of some standard affording us an expression for the luminosity of radiation? So far as the incandescent lamp is concerned, light-giving power is a perfectly definite function of the temperature and of the area of the radiating surface. We are unfortunately not in position at the present day to measure the temperature of an incandescent filament, but the time will undoubtedly come when the relation between the temperature and the quality of the light emitted by glowing carbon will be definitely known. We may indeed look forward to the development of some optical method for the measurement of the temperature of incandescence which shall be as easily performed as our present method of determining candle-power, and which shall admit of a much higher degree of precision. The comparison of lamps, the temperatures of which are the same, will then reduce itself to a question of radiating surface. Total luminosity and total energy of luminous radiation, per unit of surface, together with net and gross efficiency, may then be expressed, in so far as incandescent carbon is our source of illumination, as functions of the temperature alone, and the performance of any lamp may be defined in terms which admit of no uncertainty.

[17] C. Vierordt, *Annalen der Physik und Chemie*, Bd. 137, p. 200.
[18] Macé de Lepinay and W. Nicati, *Journal de Physique*, second line, T. 2, p. 75, 1883.
[19] Otto Schumann, *Elektrotechnische Zeitschrift*, Bd. 5, p. 224, 1884.

The Sprague Electric Road at St. Joseph, Mo.

The city of St. Joseph, Mo., is perhaps the most advanced in the West in respect to the adoption of electricity for its street cars, and one of the most successful electric street railways in the country is that of the Wyatt Park Company's there, a fine view of which we give in this issue. The first electric line to be operated in St. Joseph, was the Union Passenger Railway, equipped by the Sprague Electric Railway and Motor Company, and the success of this line has been so great that the railway company ordered an additional number of cars.

This line at St. Joseph was one of the first in the country to demonstrate practically the successful operation of an electric railway in a snow storm. In the early part of this winter a blizzard from the western prairies struck St. Joseph with all its force and covered the streets in that city to the depth of from 6 inches to 1 foot, and in many places drifting badly. The telephone, telegraph and electric light wires were borne down by the snow in all parts of the city, and trade was for the time being, according to one of the local papers, fairly paralysed. In spite of this general blockade the electric railway ran uninterruptedly, and the cars plowed their way through the heavy drifts on the line without trouble or stoppage, and without any aid from snow plows.



THE SPRAGUE ELECTRIC ROAD AT ST. JOSEPH, MO.

The road has been very largely patronized by the residents of St. Joseph, and property along the line has greatly increased in value. The grades of the Wyatt Park Railway are in some points on the road as high as nine per cent., and the cars without difficulty reach a speed of 15 to 18 miles an hour in the outside and suburban districts, reducing to a lower rate of speed when operating within the city.

St. Joseph, Mo., is in fact, as we have said, coming to the front rapidly as one of the leading cities in electrical enterprise in the West. It already has two street railways operating by electricity on the Sprague system, and a great many manufacturing industries are kept in operation by the same power by means of stationary electric motors operated from the regular railway circuit. It is understood that the two other street railways in St. Joseph will soon be in operation upon the electric system, so that the horse will be supplanted in St. Joseph for that class of work.

Watts per Candle.

To the Editor of The Electrical World:

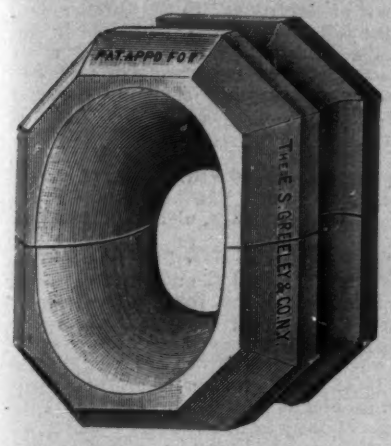
SIR: Will you inform me on the following question through your columns: How many watts are required per candle power in the best incandescent lamps?

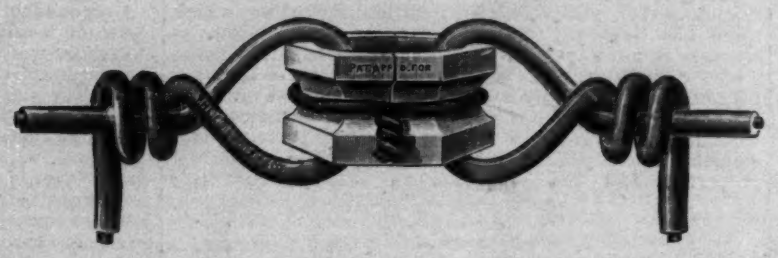
INDIANAPOLIS, Ind. C. G. D.

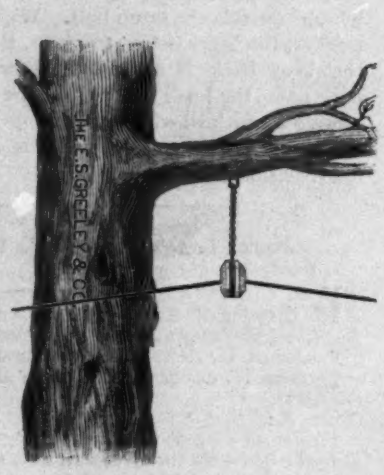
ANSWER.—The best commercial incandescent lamps in use to-day require about three watts per candle-power under normal conditions.—EDS. E. W.

The "Victor" Split Insulator and Hanger.

The E. S. Greeley & Co., of this city, have recently brought out a novel split insulator which seems applicable to a variety of line work. The insulator, known as the "Victor," is shown in Fig. 1. It is provided with an opening to accommodate the largest wire and it has a perfectly smooth bearing and locking lugs that prevent torsion of the two parts after they are bound together. For this purpose a special hanger is furnished in two sizes, 3 inches and 6 inches in length respectively. This consists, as shown in Fig. 2, of No. 14 galvanized wire twisted together, except at the ends which surround the insulator. The ends are long enough to encircle the insulator twice, after which they are twisted together, as shown.







FIGS. 1, 3, 2 AND 4.—THE "VICTOR" SPLIT INSULATOR.

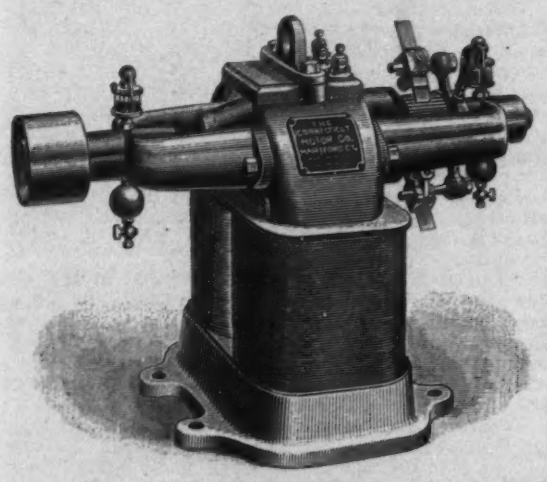
The uses to which these split insulators can be put are apparent. Being in two parts, they can be placed upon a line already erected equally as well as upon a new one; and they are specially adapted for taking up sag, for guys and "hauling off" purposes. Another use to which they can be applied is the increase of the capacity of cross-arms by suspending them beneath, and hence they are also specially adapted for the suspension of wires under elevated railway structures and in tunnels.

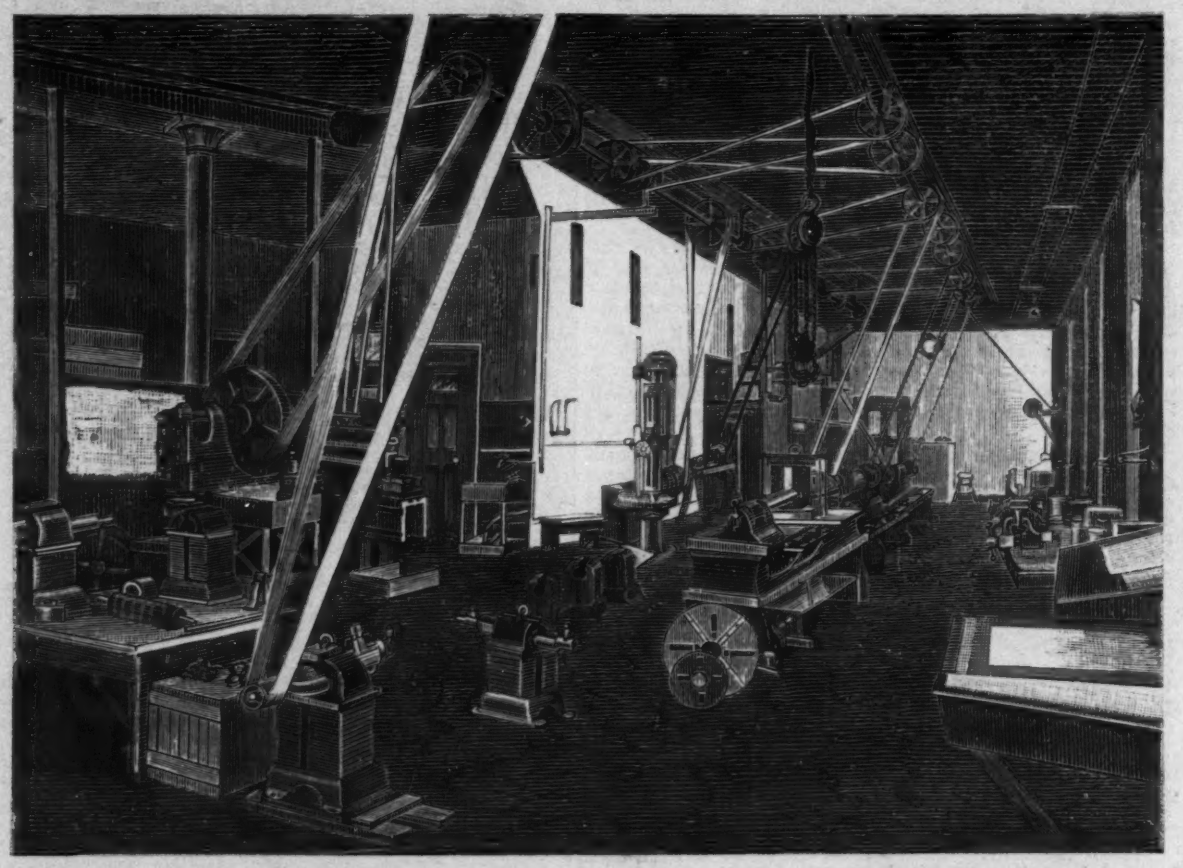
The illustration, Fig. 3, shows the new split insulator applied as a circuit breaker for arc circuits, and Fig. 4 shows its application as a tree insulator.

The Connecticut Motor.

The Connecticut Motor Company, of Hartford, was organized in the latter part of 1888 to manufacture the stationary electric motors designed by Robert E. Dunston, C.E., late of the Pilsen-Joel and Anglo-American Brush companies, of London, and known to many of our readers in connection with the technical work of the old Schuyler Electric Light Company. The directors and principal stockholders of the Connecticut Motor Company are S. M. Gladwin, president; Robert E. Dunston, secretary and treasurer; and these, with C. C. Sterling, directors.

The past few months have been employed in equipping a suitable factory, the testing department of which is shown in our illustration, Fig. 2. The company has now completed a line of shunt-wound motors of from ½ to 10 h. p. The same general design runs through all sizes, a good idea of which may be had from the engraving, Fig. 1. Although the design of the Connecticut motor possesses minor features of mechanical novelty and interest, such features are incidental only, the primary object of the designer having been to obtain such electrical proportions and arrangement of mechanical detail as would produce a machine combining high efficiency and first-class workmanship with moderate first cost.





FIGS. 1 AND 2.—CONNECTICUT MOTOR AND TESTING ROOM.

A 3 h. p. machine is now in operation at the works of the Pratt & Whitney Co., of Hartford, where it is employed in running a planing machine. This particular application of electric power is very exacting. In the present instance the power called for and given by the motor sometimes varies from ½ to 3 h. p. during each double stroke of the planer, the stroke on short cuts of 8 inches being 22 to the minute. The action of the motor is not such as might have fairly been expected under such trying conditions, for there is no sparking, and nothing but the ammeter tells of the variations which take place in the 4-inch armature.

The "Connecticut" motor is now being arranged for constant currents, and we understand that the company will make a specialty of isolated transmission for which the demand is on the increase in the mining districts.

We may add that these motors can be seen at the offices of the local agents, Messrs. Fleming & Kimball, of this city.

Annual Meeting of the New York Electrical Society.

At the meeting of the New York Electrical Society held on March 20, the following officers were elected for the ensuing year: President, Mr. Francis B. Crocker; Vice-Presidents, Messrs. Joseph Wetzler, Francis Forbes, and Dr. Otto A. Moses; Secretary, Mr. G. H. Guy; Treasurer, Mr. H. A. Sinclair.

The society then took up the discussion of "The Underground Wire Problem in New York City." Mr. C. O. Mailloux contended that the electrician had at his command all the facilities for operating electrical circuits successfully underground, and all that was needed was proper insulation and care in laying and maintenance.

This was replied to by one of the members, who drew attention to the fact that while such a doctrine was theoretically true, the cost involved in procuring such a high quality of insulation together with the rental of the conduits, would make the undergrounding of arc circuits impracticable, and the experience of Mr. B. E. Sunny with underground conduits in Chicago was cited to prove that even with the best materials available the cost of maintaining underground arc circuits was so high as to make it prohibitive.

Dr. S. S. Wheeler, the electrician of the Board of Electrical Control, described the system as laid down in New York, and adverted to the fact that cables carrying 1,000 volts alternating potential were now working successfully in this city, one on 125th street and another in 23d street; and tests showed that after a few weeks' use the insulation resistance had considerably increased, and he saw no reasonable cause for their failure in the future. A number of other speakers expressed different and varying views on the same subject.

Introducing Storage Batteries into Cars.

To the Editor of The Electrical World:

SIR: I see by THE ELECTRICAL WORLD that Messrs. Brill and Hunter are having quite a discussion about the method of introducing storage batteries into the end of a car upon slides or trays. You will pardon my trespass upon your space in order to state that if Mr. Brill will reflect a moment I am led to believe that he will remember that in 1883 I took him into my office on the second floor of the Mutual Life Insurance Building to show him the Faure secondary batteries that were placed there by some prominent gentlemen associated with me at the time in the control of that system for passenger railways, and which batteries were mounted upon plank slides in the same manner as was at first used by me in lighting the first car lighted by incandescent lamps upon the Pennsylvania Railroad running between Jersey City and Rahway for several months. And he may also remember that my object in asking him to see them was to induce him to make plans for a car operated by the Faure battery and Reckenzaun motor, which was expected in New York about that time from the parent company in London. The rough plans I submittted at that time to himself and others required the slipping of the battery mounted upon a tray or slide into the end of the car under the seats of the passengers, and if I am not mistaken Mr. Brill called attention to the fact that under the construction plans of that period some changes would be necessary to avoid the wheels of the car. That point I submitted for development to the electrician of the company in New York, who had furnished the design. As Mr. Hunter was at that time still pursuing the vocation of patent solicitor his ignorance of the prior use of that method is easily accounted for. I think I have those plans in my New York office still, and there are others extant.

PHILADELPHIA, PA. P. P. QUACKENBOSS.

Novel Electric Door Opener.

Our illustration represents a new door opener recently brought out by Messrs. E. A. Wildt & Co., of this city. In this door opener the throw back *B* which opens the door is controlled by a spiral spring, which is compressed by the closing of the door, and which is prevented from acting until the armature is attracted by the electro-magnet, and thus allows free motion to the tongue which is held by the armature. This tongue, it will be seen, is pivoted at one corner of the electro-magnet, and bearing up against it is the lever which controls the latch bolt. When the armature is attracted, the lever is free to move, the spiral spring forces the throw back *B* against the door jamb, and forces the door open, the lever controlling the latch then having free motion to withdraw. The door opener is very simple and the power of the spiral spring is sufficient to move the heaviest door.

Judge Coxe's Storage Battery Decision.

U. S. CIRCUIT COURT—Southern district of New York.
The Electrical Accumulator Company vs. The Julien Electric Company and William Bracken, in Equity.
Frederick H. Betts, for complainants.
Thomas W. Osborn and Horace M. Ruggles for the defendants.
COXE, J.:

This is an action for the infringement of four letters patent owned by the complainant, for an improvement in secondary electrical batteries. One of these, No. 266,262, granted to Shaw & Rogers Oct. 17, 1882, has been withdrawn from the consideration of the Court. The three in controversy are No. 252,002, granted Jan. 3, 1882, to Camille Alphonse Faure, and Nos. 312,599 and 318,828, granted respectively, Feb. 17, and May 26, 1885, to Joseph Wilson Swan. The invention of Faure relates to that class of batteries which give no electricity of themselves, and are active only when rendered so by sending a current through them from an independent source of electric energy—batteries which, being included for a time in a circuit generated from an ordinary galvanic battery, for example, become charged, so that they subsequently give out electricity on the completion of a proper circuit. This process may be repeated an indefinite number of times. When the battery runs down it can be charged again. The inventor describes the secondary batteries of Gaston Planté, in which, by a long and expensive operation, involving weeks, and even months, the plates are formed but with a comparatively limited capacity. To prevent this waste of time and money, and to construct a more powerful battery, was Faure's object. His electrodes are made, not by the formation of a porous layer by disintegration in the body of the metallic plates, but by adding to suitable supports a layer of active material of the desired depth, in the form of a paint or paste, or otherwise, which is, or at once becomes, spongy or porous. This active layer may be rendered more porous by mixing with the material composing it some inert material, such as crushed coke. "In charging, the electricity acts to produce a reduced mass of porous lead on one electrode, and a mass of peroxide of lead on the other. When the battery is discharged, the reduced lead becomes oxidized, and the peroxidized lead is reduced until the equilibrium is restored." The claims in controversy are the first and fourth.

They are: "1. As an improvement in secondary batteries, an electrode consisting of a support coated on one or more faces with an active layer of absorptive substance such as metal or metallic compound applied thereto in the described condition—so as to be or instantly become spongy, and thus capable of receiving and discharging electricity, as stated, in contradistinction to a metallic plate itself rendered spongy by the disintegrating action of electricity, substantially as and for the purpose set forth.

"4. In a secondary battery, a series of cells, comprising each a pair of electrodes with an active spongy layer thereon, combined with non-porous partitions between adjacent cells, substantially as and for the purpose set forth."

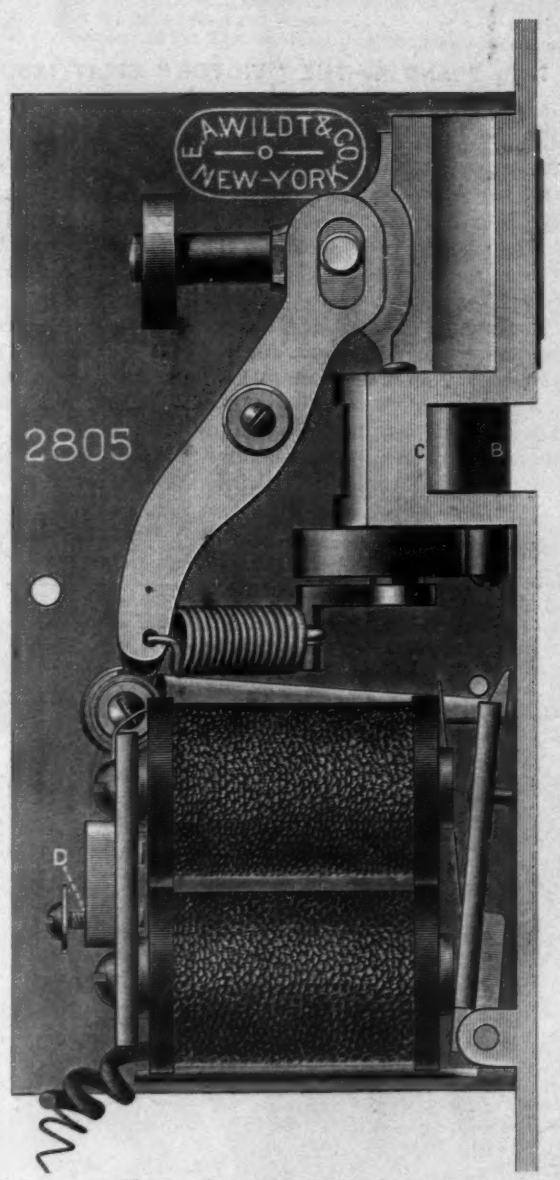
The general defense is want of novelty, which is sub divided as follows:

First, prior use. Second, anticipation in prior patents and publications. Third, public use more than two years prior to the application. Fourth, lack of invention. Fifth, the claims are too broad and include well-known prior inventions. Sixth, the patent is ambiguous and misleading and does not point out the inventions. Seventh, the original application was unlawfully expanded by amendments.

Non-infringement of the fourth claim, if construed to mean that the electrodes must be applied to the partitions, is also alleged.

That the language of the patent is ambiguous, and especially so as it relates to the first claim, seems to be conceded on all hands. If other proof were needed that it is not written in the most perspicuous language it will be found in the fact that the record contains nearly 2,000 pages, the greater part of which, as well as of the briefs, which aggregate 411 pages, is devoted to an effort to ascertain its meaning, an effort which has hardly crystallized into a demonstration upon any one of the the points in controversy.

In construing the first claim it should be remembered that it is limited to an improvement upon the well-known batteries of Gaston Planté, who was the creator of practical secondary batteries. The art began with him. A secondary battery as distinguished from a primary battery is, therefore, one element of the combination (Telephone Cases, 126 U. S. 572). A secondary or storage battery is a battery which has no original power of developing a current of electricity, and is active only when rendered so by sending a current, elsewhere generated, through it. The current produced by the secondary battery, because of the change in the surface of the plates, will run in an opposite direction to that of the current produced by the independent source of electric energy by which it is charged. A primary battery is a chemical generator of electricity which is active by virtue of the materials of which it is made. The material of at least one electrode passes into solution during the use of the battery. A primary battery is active; a secondary battery, in its inception, is passive. The two differ as a spring differs from a reservoir. In the former the electrodes are dissimilar and the battery is rendered operative by reason of the attack upon, and dissolution of, the positive electrode in the battery fluid. The other electrode collects the electric energy from the liquid. In the latter the electrodes are initially similar or substantially so. They are not acted upon by the liquid and either may be made the positive or negative electrode by its communication with the charging source of electricity. "A primary battery can only give a certain amount of current in a definite period of time, while in the secondary battery the amount of current which may be obtained from it depends entirely upon the resistance of the conducting wires discharging it." The current may be much stronger than that obtained from the charging battery. A primary battery which has become exhausted may be restored to partial effectiveness by sending a current through it, always in a reverse direction, from an independent source of electricity, in the same manner, substantially, as a secondary battery is charged. Thus the normal condition of the cell may be approximately, but not wholly, restored, for the battery constantly loses capacity until it ultimately becomes useless. Upon this branch of the controversy, the question, regarding which there has been the widest divergence of opinion, is whether or not a primary battery, thus treated, becomes a secondary battery. It is insisted on the part of the complainant that it is only a partially regenerated primary battery; that it lacks the essential characteristics of a secondary battery. In a secondary battery there are two elements initially alike or substantially alike in electric properties and not separated in the electro-motive



A NOVEL ELECTRIC DOOR OPENER.

scale; both are, in the first instance, chemically inactive and practically insoluble in the electrolytic liquid; either may be connected with the positive pole of the charging battery and at any time the current may be reversed; the process of charging and discharging may be repeated indefinitely without loss of force or undergoing physical change. None of these distinguishing features are found in the restored primary battery.

On the other hand, the defendants contend that a secondary battery may be one which at any stage of its existence has come to a state of electrical equilibrum so that it can give no electricity of itself. In other words that a secondary battery may be a primary battery which has become exhausted and charged from an independent generator. That the distinction between the two lies not in the construction of the battery, but rather in its condition, so that the same battery may at one time be primary in its action and at another time secondary. When the chemical energy of the battery has an electric origin the battery is called a secondary one, when it has not such an origin it is a primary one.

It is well nigh impossible to reach an accurate and comprehensive definition so that batteries of all varieties can be instantly classified. There are well known primary batteries and well-known secondary batteries, but between these there is a narrow, debatable ground occupied by actual and suppositive hybridous structures which can hardly be included in any general definition or placed in either group. At this point it may be said, generally, that an ordinary well-known type of a primary battery, does not, it is thought, become a secondary battery, as that term is understood by electricians, because it is partially restored by sending a reverse current through it. The possession of the knowledge that this may be done would not aid materially in the construction and operation of a secondary battery. The patent is addressed to those having a peculiar and technical knowledge of the subject (Loom Co. vs. Higgins, 105 U. S., 580, 585). Terms of art are used. When, therefore, one electrician speaks to another of a secondary battery he does not mean, and will not be understood to refer to, an exhausted primary battery, but to the structure before described. For the purpose of this case no greater particularity or refinement of the definition is necessary.

The claim further provides "for an electrode consisting of a support coated," etc. It is insisted that by a necessary implication the claim is limited to the use of two similar electrodes. The argument in support of this theory is ingenious, but it is answered by the plain language of the claim. An electrode cannot mean two electrodes. Had the patentee so thought or intended, he would hardly have used the words "a pair of electrodes" in the fourth claim. The French patent, the file wrapper and the patent in suit all demonstrate that the patentee had his attention sharply drawn to the distinction between one electrode and two electrodes, and that he deliberately and intentionally claimed the former. He must abide by his decision. Sutter vs. Robinson, 119 U. S., 530, 541; Shepard vs. Carrigan, 116 U. S., 593; Roemer, vs. Peddie, 27 Fed. Rep., 702; Caster Company vs. Speigel, 26 Fed. Rep., 272.

A secondary battery, therefore, containing one Faure electrode would be within the claim, although the other electrodes were dissimilar, provided the two operate to receive and discharge electricity as stated in the specification. The plates may be of metal (lead, for instance) or of a non-metallic substance (carbon, for instance) coated on one or more faces with an active layer of absorptive substance, which may be "metal, metallic oxide or salt—which layer is or at once becomes porous or spongy." The porous coating may be of lead or any of the salts of lead. Metallic compounds, as well as metals, may be used. Preference is expressed for spongy lead, but other coatings are included. "This active material may be applied in various ways, so as to obtain a layer of the desired depth, as in the form of paint, paste, or cement, in the form of a deposit by galvanic action or chemical precipitation, or otherwise." It may be applied—that is, added to and formed out of the plates, in any suitable way, so only it is of the desired thickness and of sufficient uniformity to be an improvement on Planté. It must operate successfully in a secondary battery and instantly become permeable to the liquid and thus be capable of receiving and discharging electricity.

It is asserted by the defendants that the claim is broad enough to cover an electrode, the active layer of which is soluble in the electrolyte and one to which the layer is applied after immersion in the battery fluid by galvanic deposit or chemical precipitation out of a solution in the liquid. The complainant, on the other hand, insists that the proper construction is that the absorptive substance, which is insoluble in the electrolyte, must be applied prior to the commencement of charging the battery, and, consequently, prior to the immersion of the electrode in the battery liquid. Each of these conflicting theories finds support in the contradictory and ambiguous statements of the specification. The experts seem to agree that the claim covers an electrode coated with a suitable active layer deposited thereon mechanically, chemically or electrolytically. The complainant's witnesses think the method of application as a paint, paste or cement to be the most advantageous and that the specification indicates, by strong implication, that this was Faure's opinion also. They consider, however, that all the described methods are included in the claim, with no preference expressed for any one. When the layer is applied mechanically, it naturally must be before immersion in the battery fluid, but it can hardly be said that galvanic action refers to another than the charging battery or that chemical precipitation refers to other than the battery liquid. The patent does not express a preference for the pre-applied layer, and the most natural and sensible interpretation would seem to be that when the layer is to be formed electrically it shall be by galvanic deposit out of a solution in the electrolytic liquid itself. The plate can as well be coated there as in another liquid, and to coat it elsewhere would seem to be a cumbersome and inconvenient process.

But it is said that the description of the charging and discharging process indicates that the coatings are pre-applied. That otherwise the charging would not operate to reduce immediately the layer to porosity or sponginess on one electrode and peroxidize it on the other. It would not at once become spongy, unless placed there before the plates were put in the battery liquid. But it would seem that this contention can hardly be maintained in view of the express language used.

Again, the patent is not specific upon the question, whether or not the absorptive substance shall be insoluble in the battery fluid. The language which directly bears upon this point is as follows:

"The oxides or salts of lead not soluble in the electrolytic liquid are deemed the most advantageous for covering the supports of the electrodes. The invention is not, however, limited to these, but includes generally substances capable of absorbing and storing electric energy in the manner described; for example, manganese or any salt the oxide of whose base is insoluble."

Whatever may be said of the active layer, there can be no dispute that this language is insoluble. No one connected with the cause professes to understand it. It is unique as a specimen of closely-woven ambiguity. The complainant's counsel admits that the first sentence implies that a soluble layer may be employed, but he thinks the second sentence indicates that this is not the correct view, and that the intention of the patentee was to include only porous layers which are capable of absorbing and storing electric energy in the manner described, namely, by deoxidizing on one electrode and peroxidizing on the other when the battery is charged, and by oxidizing the spongy layer and deoxidizing the peroxidized layer when it is discharged. It is insisted that this operation is not possible if the active layers go into solution that they would not then absorb or store electricity. On the other hand, it is contended that the patentee did not intend to limit the invention to the oxides or salts of lead not soluble in the battery fluid, but wished to include generally all substances as materials for covering the supports which are capable of absorbing or storing electricity, electrolytically. The patentee specifically states that the invention includes manganese. A support would be within the invention, therefore, if coated with the sulphate of manganese, which is a salt soluble in the liquid, though the oxide of its base is insoluble.

It is thought, then, that the language of the patent, although by no means clear, can hardly be construed to

exclude a coating soluble in the electrolyte. Why the patentee, having invented a practical, efficacious and meritorious method, should have used language which apparently includes an inferior and comparatively useless one is, indeed, inexplicable. That it was intentional can hardly be imagined. If these conclusions are correct it follows that the claim should be construed to cover:

FIRST. A secondary battery as distinguished from a primary battery.

SECOND. An (one) electrode in the battery capable, in conjunction with the other electrode, of receiving and discharging electricity as described.

THIRD. The said electrode formed of a plate of metal or carbon or any suitable non-metallic substance.

FOURTH. The active layer of sufficient depth and uniformity to operate successfully added to the plate in any suitable way as a paint, paste, or cement, or electrolytically, or chemically.

FIFTH. The active layer of spongy lead or any metallic compound capable of satisfying the conditions of the patent as to porosity, etc.

SIXTH. Any suitable electrolytic liquid.

It now becomes necessary to ascertain whether the invention, as so described, is anticipated or rendered void for want of patentable novelty by anything disclosed in the prior art, and, if so, whether the real invention of Faure can be saved by a disclaimer of non-essential features inadvertently inserted in the specification.

The defendants have introduced an immense number of exhibits, which show the steady evolution in batteries, both secondary and primary. As to a vast majority of these, it is not pretended that they anticipate. They may be interesting from a scientific standpoint, but they shed little light upon the issues in controversy, and rather tend to confuse them. In order to determine who shall be rewarded in the race for invention it is not essential to note the efforts of those contestants who have dropped out during the first half of the contest. Those who reach the goal are to be considered, and the one who reaches it first is entitled to the prize. It is only necessary, therefore, to examine those exhibits which show the closest approximation to Faure's invention.

The article from the *Electrician* of 1868 is entitled "Secondary Batteries." The writer, after describing a battery charged from an independent source, and which contains a couple like Planté's, except that the positive element is of zinc instead of lead, says: "We have by preference employed for the primary battery a few Daniell's cells, which, although much less rapid in their action than the Bunsen cells, suffice for the production of the peroxide of lead, on which the efficiency of this secondary battery depends.

"The great power of the secondary combinations we have referred to is due to the presence of the peroxide of lead in contact with the negative elements in these combinations."

The writer then describes a negative element of platinum or lead, surrounded by a mixture of dilute sulphuric acid and peroxide of lead, and a positive element of amalgamated zinc in dilute sulphuric acid. He says further: "By the action of a battery of any kind, provided the tension or electric motive force be sufficient, we may readily obtain a secondary couple, or any number of secondary couples, constituted therein upon the principle of Grove, or according to the plan of De la Rive, of using the peroxide of lead instead of nitric acid. Such secondary couples may be capable of remaining in action only for a few minutes or for very much longer space of time, according to the period which they are charged by means of the primary battery."

The plan of De la Rive, referred to, describes as an electrode for a primary battery a thin plate of platinum placed in a porous pot, with a powder of peroxide of lead, and, in some instances, the peroxide of manganese, packed around it. This arrangement is quite similar to the negative electrode of Leclanché's United States patent No. 165,452, and to the Faure electrode shown in Fig. 2 of his drawings. In fact, if the other electrode shown in this figure were amalgamated zinc instead of "a piece of lead with its inner face covered by a paste of sulphate of lead," the analogy would be well nigh perfect.

The difficulty with the article as an anticipation seems to be that there is no pretense that in charging the battery therein mentioned "the electricity acts to produce a reduced mass of porous lead on one electrode and a mass of peroxide of lead on the other."

To one not versed in electrical science the operation described in the *Electrician* would seem to differ but little from the act of restoring a cell of De la Rive or Leclanché by the application of a current from an external source sent through it in an inverse direction.

The article is not illustrated by drawings, the descriptions are somewhat vague and general, and there is no evidence that a successful secondary battery having the charateristics mentioned was ever made; on the contrary, structures quite similar were proved to be inoperative and valueless.

It would seem that the article "relates to that class of batteries which give electricity of themselves." A person skilled in the art, after reading it, would not be able to construct a Faure battery in any of its practical forms. It does not, therefore, anticipate unless a very broad construction is given to the claim.

The report of the Smithsonian Institution for 1856 describes a secondary battery of any number of platinum plates containing a current of far greater electromotive force than that of the charging battery. The plates were platinized; that is, platinum-black had been deposited thereon electrolytically, producing a microscopical film of finely divided platinum of a thickness "not far from the hundredth part of the thickness of a sheet of thin paper." Though the operator obtained a better result with the plates thus coated than when they were bright, he seems to have been oblivious as to the reason therefor.

The gas battery of Mr. Grove was made with two strips of platinum covered by glass tubes holding oxygen and hydrogen gas, respectively. These strips were platinized and the platinized metal formed with amalgamated zinc into a battery.

Kirchof's United States patent, No. 31,545, describes a battery, each cell of which contains a pair of platinum electrodes. The cells are glass cups, filled with a solution of the salts of lead. Upon being connected with a charging battery "the negative electrode will turn black peroxide of lead, and the positive electrode will be surrounded by crystalized lead. This is a very positive element, and the former (peroxide) the most negative known to exist, and also a good conductor. By changing the proportions of the substances of the solution more or less peroxide of metal will be deposited, and the conducting power, etc., may be increased or decreased in the same ratio."

This would seem to describe a secondary battery with two initially similar platinum plates both coated by the charging current with a layer of active material.

The criticism of this reference is that it shows a battery which, in the initial state before charging, has no coating of any kind on the plates. The coatings are produced out of and at the expense of the battery fluid, and as the gradual and slow result of charging. But this criticism loses sight of the statement of the patent that the active layer may be deposited by galvanic action.

Planté, too, described, in 1872, his attempts to produce a thicker layer of peroxide of lead by galvanic deposit at the expense of the liquid. He says: "If we make use of alkaline solutions the lead is deposited in a spongy form which increases rapidly in volume and presents an analogous inconvenience to the one just given. Further, the peroxide of lead once deposited is not attacked when immersed in the alkaline solution as it is in water acidulated by sulphuric acid, so that there is obtained under these circumstances only a very feeble secondary current. I have, therefore, thus far limited myself to the employment of water acidulated with one-tenth of sulphuric acid which has always furnished by its action upon the peroxide of lead a secondary current superior in intensity to that of all other combinations either acid or alkaline."

The idea of Percival also, as shown in his United States patent No. 53,668, was to improve on Planté's method by saving time and expense. He describes a secondary battery consisting of one pair of electrodes placed in a watertight wooden box, divided in its centre by a porous partition. On each side of this partition is a layer of powdered gas carbon. These layers constitute the two electrodes, and when in use they are wet by a proper solution. For convenience in establishing connection with these layers, there is on each end of the box a screw cup fastened to a strip of copper which is in contact with the carbon. "Lead or any other suitable metal in the form of a coarse powder may be substituted for the gas carbon." This appears to be somewhat analogous to some of the forms described by Faure. The complainant contends that the reference is valueless for the reason that there is no suggestion of a conducting support plate like Faure's, which holds the active layer and conducts electricity to each and all parts of it, so that the whole material instantly becomes spongy, and thus capable of receiving and discharging electricity. In short, that the Percival battery is without the Faure support plates.

Regarding the prior use sworn to by Professor Vander Weyde it must be held that upon his testimony alone the Court would not be justified in overthrowing the patent. The granting of the patent raises a strong presumption of novelty. Clear and convincing proof must be advanced to offset it. Proof which leaves the mind in doubt or evenly balanced upon the question is not enough. It is permissible for the Court to reject the evidence, unless it is of such a character as to remove uncertainty and doubt.

Coffin vs. Ogden, 18 Wall., 120. Wood vs. Cleveland Rolling Mill Co., 4 Fish. 550. Howe vs. Underwood, 1 Fish., 160. Webster Loom Co. vs. Higgins, 4 Ban. & A., 88.

In the present instance the witness testifies to what occurred fourteen and twenty-five years ago. He is a man of great learning and research. Though visionary and a confessed theorist, he is restless, energetic and untiring in his labors "in the dark and profound mine" of science. During the period between his alleged discovery and his testimony, the subjects that occupied his attention were numberless. As an illustration, he testifies that during these years he took out more than thirty patents, and wrote at least five thousand articles on scientific subjects. That such a man, with his attention engrossed to such a phenomenal extent, should be able to recall with perfect accuracy experiments and results made and reached by him nearly a quarter of a century ago seems amazing. He may be mistaken, he may have confused experiments unintentionally, he may have exaggerated results. All this is possible, if not probable. In some matters his statements are clearly shown to be inaccurate. He is wholly uncorroborated. He asserts that his attention was called to the subject by reading in a foreign publication in 1864 an article which practically anticipated Faure. No such publication is produced, and it is hardly possible that it could have existed. He was, therefore, referring to something which he saw after the Faure invention, or he entirely misconceived the purport of the article. If he were the author of the great improvement made practical by Faure, it is surely remarkable that he should have allowed the secret to perish. If he did not consider it of sufficient value to make it the subject of a patent it would seem, at least, that he might have mentioned the fact in one of his five thousand publications. There is not a reported case, where, upon such proof unsupported by other evidence, a patent has been overthrown. In the Telephone cases, 126 U. S., 546, a far stronger case of prior invention was made out for Drawbaugh. He was corroborated by a host of witnesses, but the improbability of his story induced the majority of the Court to disregard it. That he should have made this wonderful discovery and yet remain mute while the world was ringing with admiration for Professor Bell's invention was too far opposed to "the ordinary laws that govern human conduct" to receive the sanction of the Court. But even if Professor Vander Weyde's testimony were corroborated so as to leave no doubt as to the accuracy of his statements, his acts must, within the authorities, be regarded as unsuccessful experiments. His researches so far as any useful result is concerned, were as abortive as those of the alchemists. He accomplished nothing. He made several experiments in a small way, but they were chiefly for his own instruction. As to several, he admits that they were utter failures, and of others he says: "I did not consider them of much importance, as I never applied them to any practical results by constructing a storage battery. It is, perhaps, one of my defects to search out properties of substances, chemical or electrical, and when I have found them I neglect the practical application, being often led off in another line of research." This was apparently the difficulty in the present instance; he neglected "the practical application," the matter passed from his mind, the implements used by him were forgotten amid the rubbish of his cellar.

The language of the Court in Putnam vs. Hollender, 19 Blatchf., 48, can with propriety be applied. At page 62, Judge Blatchford says:

"The defendants have not shown that the invention was complete and capable of producing the result sought to be accomplished. * * * The thing was inchoate and rested in experiment. The process pursued for its development failed to reach the point of consummation. However nearly Otto approximated to the end in view, he only made progress. The world derived no benefit from what he did. The recollection of it was stimulated by the success of De Quillfeldt's invention. But for that, Otto's structure would have still been reposing in the old trunk beneath the stairs forgotten and worthless."

See also Putnam vs. Hofe, 19 Blatchf., 63. Gayler vs. Wilder, 10 How, 477. Hall vs. Bird, 6 Blatchf., 438. Tilghman vs. Proctor, 102 U. S., 707. Andrews vs. Carman, 13 Blatchf., 307. Hicks vs. Otto, 22 Blatchf., 94. Clough vs. Gilbert & Barker Co., 106 U. S., 166. Walker on Patents, 86.

The evidence of prior invention by Charles F. Brush is now to be considered. In determining this question, Faure, being at that time a citizen of France, is not permitted to claim the invention earlier than the date of his French patent, which was Oct. 20, 1880, and possibly not earlier than Dec. 7, 1880, which is the date of the decree (*arrête*) under which it was delivered.

Mr. Brush is an electrical engineer, and is a prolific inventor and patentee in connection with arc lighting and other electrical subjects. He testifies that in the latter part of 1878 he first became familiar with the discoveries of Planté, and learned that the lead plates constructed by him required several months of electrical treatment in order to produce the necessary active coatings on their surfaces. In December, 1878, or very early in 1879, he conceived the idea of making a secondary battery by applying mechanically to suitable plates an active or absorbing coating, so that such plates might be used at once, after suitable charging, for electrical storage purposes, without the tedious, preliminary forming process described by Planté. In the summer of 1879 he embodied this idea, making a secondary battery by applying to suitable plates or supports, by mechanical means, an active or absorbent coating. For this purpose he took a piece of sheet lead about 3 inches wide and about 12 inches long and sprinkled thereon finely divided metallic lead, in the form of a fine powder, which could be passed through a sieve. This layer was about one-sixteenth of an inch in thickness and it extended the whole width of the plate and about three-fourths of its length. The lead powder was held in place by blotting paper, the edges of which were turned back and under the plate at the sides and bottom. A narrow strip of wood was laid longitudinally on the blotting paper and the whole was wound tightly with a string. This plate was suspended in a tall glass jar, nearly filled with dilute sulphuric acid, and formed the oxygen element of the cell. The hydrogen element was a plate of amalgamated zinc suspended opposite the prepared lead plate in the glass jar. Soon after the completion of this cell he prepared two more lead plates in exactly the same manner as the one described, and hung them both in a tall glass jar filled with the same electrolyte. In this cell one of the prepared lead plates formed the oxygen element and the other the hydrogen element. He connected this cell in series with the one first described and charged it by means of the current from a dynamo-electric machine. The strength of the current was not measured, but it was somewhere about five ampères. He charged the cell several hours on each of several days before commencing to discharge it. He discharged it through a fixed and constant resistance and noted the time which the current lasted and was thus able to compare the performance of this cell quantitatively with that of other cells discharging through the same resistance. This resistance consisted in the helices of the electro-magnet of a single-stroke electric call bell. Upon the passage through this magnet of the current from the secondary battery cells its armature was strongly attracted. He found that the electrical storing capacity of the prepared plates was very much greater than that of the Planté plates of the same size. During the first few weeks, after the construction of the cell with the lead plates as described, he discharged and re-charged it frequently, and sometimes daily. After that he always kept it charged, and discharged it less frequently up to May, 1880. Besides ringing the electric call bell, he used the cell of this battery in connection with other secondary cells for exciting a large electro-magnet with which he magnetized permanent magnets. He also used it in connection with other cells for the heating of platinum and iron wires and for the ocular demonstration to others of the storage of electricity. About the same time he made two other cells alike in every particular, except that the coating was, in one instance, of red oxide of lead and in the other of litharge. He subjected these cells to the same treatment as the ones first described with substantially the same result. He says of these cells that "they were all completed, finished and operative storage batteries from the time of their construction and first charging up to the time of the fire when they were destroyed. They all operated successfully and reliably during that time."

All of the results obtained by Mr. Brush were carefully noted down and preserved, some in the form of entries in a diary and some on loose sheets of paper. On the 6th of May, 1880, his laboratory with its contents was totally destroyed by fire. His diary and the loose memoranda concerning his experiments were all lost.

In July, 1880, Mr. Brush made lead plates with deep grooves; into the grooves of some he rammed yellow oxide of lead, and in others sulphate of lead. These plates were laid grooved side up in suitable vessels containing dilute sulphuric acid with a piece of metallic zinc in contact with the plates. By this electrical action continued for many days, the oxide and the sulphate in the grooves was reduced to metallic lead and the zinc went wholly or partly into solution. He suspended opposite each other in a vessel of dilute sulphuric acid two plates which had originally had sulphate of lead in their grooves, and in another cell he suspended two plates, the grooves of which were originally filled with oxide of lead. These plates were four inches long by two wide, and were immersed till the grooved portion was covered by the liquid. These cells were charged by a Smee battery. They were charged and recharged many times. In March, 1881, they were accidentally lost during a removal. Early in September, 1880, he prepared six deeply grooved lead plates and filled the grooves of two of them, ramming them full of litharge, and of two more similarly with sulphate of lead. He then treated them as he had the July plates, and in a few days the oxide

of lead in one case and the sulphate of lead in the other case was reduced to the metallic state. He suspended the two plates which had been filled with oxide of lead opposite each other in a jar filled with dilute sulphuric acid and treated similarly the pair having their grooves originally filled with sulphate of lead and the pair whose grooves were not filled at all. He marked these cells respectively 1, 2 and 3, and connected them in series, charged them from a dynamo and made several tests.

After the fire in 1880 a full memorandum was kept of the experiments and results obtained. After Faure's patent was issued in January, 1882, interferences were demanded by Brush and resulted in decisions in his favor at all stages during the progress through the Patent Office.

In many important features of his testimony he is corroborated by the evidence of three witnesses who were present and saw many of the experiments referred to. After the fire Brush undertook to reproduce from memory the memoranda which had been destroyed, and criticism is made that he does not describe with particularity the batteries which he now says he invented, though he does describe with great detail other and inconsequential experiments. It is unfortunate that his reproduced notes should be so meagre on the points in controversy, that his original apparatus should have been destroyed, and that his battery of July, 1880, should have been lost. Improbabilities and inconsistencies in his statements are pointed out, and it is asserted that none of the experiments detailed by him amount to a perfected invention. Although it is unquestionably true that this proof might have been more convincing and satisfactory it is also true that there is nothing opposed to it, but presumption, conjecture and guesswork based upon its inherent defects. There is no fatal improbability, as in the case of the other alleged prior inventor, and the Court would not be justified in rejecting, for the reasons suggested, the testimony of four intelligent, respectable and apparently fair and honest witnesses. The testimony of Mr. Edmunds and Mr. Hayes is not inconsistent with the statements of Mr. Brush. It is not surprising that he did not care to disclose his experiments to Mr. Edmunds, and when they met and conversed in Paris his application was on file in the Patent Office. Nor does it avail the complainant that the Brush structures were experimental as distinguished from commercial batteries. If the invention was made it cannot matter how it was made or for what purpose. It is only where experiments fail to reach the desired result, and are abandoned as failures, that they are rejected as proof of want of novelty. They are not rejected when they are carried to successful consummation. Waterman *vs.* Thomson, 2 Fish., 461. Aiken *vs.* Dolan, 3 Fish., 197, 203. Walker on Patents, Secs. 63, 86.

The evidence of Mr. Brush as to what he accomplished in 1879 and 1880 must be accepted as true, and although Faure was *de facto* the first inventor Brush was *de jure* the first inventor of the electrodes described by him. It is not, however, contended for Mr. Brush that he applied the active layer to any of his electrodes in the form of a paint, paste or cement.

It, therefore, becomes apparent that the combination of the first claim, construed as it must be construed under the loose and inaccurate language of the specification, is anticipated in every form in which the active layer can be applied, save one, namely, in the form of a paint, paste or cement. The question now to be considered is, can the patent be saved to this extent? The application in the form of a paint, paste or cement was the real invention which Faure made. It was in this form that he gave it practical embodiment, it was this that the scientific world understood to be his improvement. An electrode for a secondary battery with the active layer applied in this form has many undoubted advantages over an electrode otherwise coated. It can be applied more evenly; it more readily adheres to the support; it does not shift its position, it "will also pack more closely and readily and make an adherent layer from which air can be thoroughly excluded so that uniform contact with the plate and throughout the mass of applied material is secured," and, finally, a greater and less expensive storage capacity can be obtained.

There can be little question, upon this proof, that Faure made his discovery as early as August, 1878. Scientific people at once recognized the progressive step taken and to him was accorded the credit of an invention of extraordinary merit.

Sir William Thomson says: "I knew the Planté secondary battery prior to 1880. Faure's invention was a very great improvement on it, so great as to produce a valuable apparatus for a large practical work instead of merely an interesting and instructive scientific instrument, which Planté's secondary battery was."

It does not appear that Sir William Thomson had the Faure patent before him but he considered that "Faure's invention was the application of two plates—preferably lead plates—of a thin layer of oxide of lead mechanically applied prior to placing the plates in the battery fluid, the plates and their coatings being insoluble in the battery fluid, and the coatings becoming so altered by the charging current as to become capable of yielding a reverse current, and this over and over again an indefinite number of times. I consider the novelty of Faure's invention to be the application of the oxide of lead to the lead plates before passing an electric current through them, and the rendering of these coatings active by immersing them in the battery liquid and passing the charging current through them."

Professor Barker, the expert witness for the defendants, says: "To Mr. Faure was due, in my judgment, all the credit which accrued by producing the porous or spongy metallic layer by the method of applying a layer of active material prior to commencing to charge the battery over that due to Planté for producing substantially the same result by the method of disintegration." And again, "I think an electrode formed mechanically would have an advantage of construction in most if not all cases over an electrode electrolytically coated."

Professor Vander Weyde says: "I am of the opinion that there are three inventions which are of leading, supreme and equal importance in the construction of a successful storage or secondary battery, to wit: (1) The mechanical application of a previously prepared compound or paste of the active material; (2) the securing of such material to the plate or support by means of recesses in the plate which it enters; and (3), the use of an inoxidizable plate or support.

Mr. Van Size, an expert witness for the complainant, says; "Faure made a discovery which threw additional light on the art of making commercially successful secondary batteries. As the specification states, he was familiar with Planté's battery, and with its degree of effectiveness, but to just what that effectiveness or superiority was due does not appear to have been known prior to Faure's invention. Faure discovered that the efficiency of Planté's battery was due to the use of finely divided spongy lead as a positive element, and his invention is embodied and the discovery outlined in the first claim of the patent."

The inventor himself says of his earliest experiments: "I took two plates of lead about two and a half inches wide, covered each plate on one side with a paste of litharge, etc. * * * I do not claim to have invented spongy lead, but I boast of being the first that produced it in large quantity on the electrode of a battery, and the first to recognize it as an efficient element of a secondary battery."

It is, then, established with reasonable certainty that the discovery of a mechanically applied layer of lead, or like substance, insoluble in the electrolyte and placed upon the supports in the form of a paste, paint or cement prior to their immersion in the battery fluid, so as instantly to become porous and capable of receiving and discharging electricity, was one of great merit. There is no doubt either that Faure was the first to make this discovery. Can he hold the fruits of his genius, or must the Court decide that in attempting, through mistake or ignorance of what had previously been accomplished, to grasp more than he was fairly entitled to, he has lost what actually belonged to him? Believing that Faure is an inventor of more than usual merit, it can readily be inferred that the Court enters upon this inquiry with every disposition to give him the benefit of his actual invention, if possible to do so under the law.

The proof establishes two propositions with equal clearness. First, Faure was the inventor of a secondary battery electrode coated in the manner stated; and, second, he was not the inventor of an electrode otherwise coated.

If, by means of a disclaimer, the patent can be restricted to the actual invention this course should, in fairness, be adopted.

Section 4,922 of the Revised Statutes provides that: "Whenever, through inadvertence, accident or mistake and without any willful default or intent to defraud or mislead the public, a patentee has, in his specification, claimed to be the original and first inventor or discoverer of any material or substantial part of the thing patented, of which he was not the original and first inventor or discoverer, every such patentee, his executors * * * and assigns * * * may maintain a suit at law or in equity, for the infringement of any part thereof, which was *bona fide* his own, if it is a material and substantial part of the thing patented and definitely distinguished from the parts claimed without right, notwithstanding the specifications may embrace more than that of which the patentee was the first inventor or discoverer. But in every case in which a judgment or decree shall be rendered for the plaintiff no costs shall be recovered unless the proper disclaimer has been entered at the Patent Office before the commencement of the suit. But no patentee shall be entitled to the benefits of this section if he has unreasonably neglected or delayed to enter a disclaimer."

Section 4,917 provides as follows: "Whenever, through inadvertence, accident or mistake, and without any fraudulent or deceptive intention, a patentee has claimed more than that of which he was the original or first inventor or discoverer, his patent shall be valid for all that part which is truly and justly his own, provided the same is a material or substantial part of the thing patented, and any such patentee, his heirs or assigns, * * * may on payment of the fee required by law make disclaimer of such parts of the thing patented as he shall not choose to claim or to hold by virtue of the patent or assignment, stating therein the extent of his interests in such patent. Such disclaimer shall be in writing * * * and it shall thereafter be considered as part of the original specification. * * * But no such disclaimer shall affect any action pending at the time of its being filed, except so far as may relate to the question of unreasonable neglect or delay in filing it."

Mr. Walker, in his work on patents, at sec. 193, has blended these two sections in one comprehensive and perspicuous explanation. He says (sec. 194 *et seq.*): "The primary fact which brings the law into play is the claiming by a patentee of materially more than that of which he was the first inventor. Such errors may spring from inadvertence. That is to say, they may spring from failure on the part of the writer of the claims to exercise proper care in penning them. So, also, they may arise from accident, from chances against which even diligent care cannot always guard. But mistake is the most common source of such errors, and such errors may arise from mistake of fact or from mistake of law. * * If the patentee is willing to eliminate from his claims, everything which later information shows had been invented before him, he ought to be allowed to retain his exclusive right to the residue. * * * There are cases where two or more inventions are covered by one claim, and in such cases a disclaimer may be made to expunge one of those inventions from that claim without disturbing the others."

Mr. Curtis says: "Specifications may also be amended by another process, that of filing a disclaimer, whenever, through inadvertency, accident or mistake the original claim was too broad, claiming more than that of which the patentee was the original or first inventor, provided some material and substantial part of the thing patented is justly and truly his own * * * In Seed vs. Higgins (8 Ell. & Blackf., 755, 771), the patentee * * * entered a disclaimer, declaring 'For the reasons aforesaid, I do hereby disclaim all application of the law or principle of centrifugal force as being part of my invention or comprised in my claim, except only the application of centrifugal force by means of a weight acting upon a presser, so as to cause it to press against the bobbin, as described in said specification.' It was held by the Court of Queen's Bench, and affirmed by the Exchequer Chamber, that this disclaimer was valid, and that the general specification being read in connection with it, the result was a claim for only the machine particularly described." (Curtis on Patents, Secs. 286, 287).

In Aiken vs. Dolan, 3 Fish, 197, the patent was for an improvement in knitting needles, and the proof showed that the patentee was the first inventor of an improved latch needle with a curved elevation which was highest at the middle of the groove, and with such a corresponding elevation of the pivot that the end of the latch was depressed when it fell back at that extremity of the groove where the latch of the primitive needle had projected upward. The claim was as follows:

"What I claim as my invention, and desire to secure by letters patent, is the application of a latch or tongue applied to the hook of the needle, and operated as herein described."

The Court says (pages 206, 207): "But when the actual invention is thus referred to this improvement alone, the claim in the specification is too broad. It states that the invention consists in the application of the latch or tongue in connection with the hook of the needle, sweeping freely back and forth upon the centre pin. The general operation of a needle latch is described, without any specific restriction in the form represented in the drawings * * * The patent is therefore broader than the actual novelty of the invention. By a proper disclaimer of the invention of latch needles without any such curvature, the patent would, however, be sustainable for the actual improvement."

In Meyers *vs.* Frame, 8 Blatchf. 446, the claim was for "the employment or use of the deflecting plates *E*, *E*[1], one or both," etc. Judge Blatchford held that "the disclaimer of the use of only one deflecting plate with the saw, and the limitation thereby of the first claim to the use of the two deflecting plates with the saw, was proper, and the disclaimer was in proper form."

In Taylor *vs.* Archer, 8 Blatchf., 315, the claim was for "the use and application of glue, or glue composition, in the tubing, substantially as described, for the purpose of making the flexible tubing gas tight, whether of cloth, rubber or other gum."

A disclaimer, filed *pendente lite* of that part of the claim, "which claims, as an improvement in flexible tubing for illuminating gas, the use and application of glue, thereby limiting the claim to the use and application of glue composition in the tubing, substantially as described," was held to be valid.

In Tuck vs. Brambill, 6 Blatchf., 95, the claim was for "The forming of packing for pistons of steam engines either in connection with an India-rubber core or without."

It was held that the claim was equivalent to two separate claims, one for the forming of the roll with the core and another for the forming of the roll without the core. That the former was new but the latter was old, and the patentee had a right to disclaim what was old and retain what was new.

In Schillinger vs. Gunther, 17 Blatchf., 66, it was held that a disclaimer which took out of the patent so much thereof as claimed a concrete pavement made of plastic material laid in detached blocks or sections, without interposing anything between their joints in the process of formation, and which limited the claim to such a pavement when free joints were made between the blocks by interposing tar paper, or its equivalent, was good. It was held, further, that it was not improper in connection with a disclaimer of a claim to eliminate or withdraw by the same instrument the parts of the body of the specification of which the disclaimed claim, or part of a claim, is founded (see also Schillinger vs. Gunther, 14 Blatchf., 152).

In Roemer vs Newman, 26 Fed. Rep., 102, the patent for a lock was held void for want of novelty, on the ground that it could not be limited so as to include in the claim certain notches in the end-pieces. The Court said: "There is no reference in terms either in the specification or the claim to notches or recesses in the end-pieces. The drawings, however, show the end-pieces formed with notches or recesses, and the patentee incidentally refers to a use to which the end-pieces may be applied, in which inferentially the notches or recesses would be necessary. This falls far short of making the notches or recesses an essential feature of the invention. It cannot be doubted that the reference in the specification is to be treated merely as recommendatory of a form of lock-plate for a specified use, such as is shown in the drawing."

After this decision was rendered the patentee filed a disclaimer disclaiming "in the first and second claims any blocks B that have not the notches formed in them as shown in the drawing," and thereupon asked for a hearing. A rehearing was ordered, Judge Wallace observing, "Such a disclaimer as has been entered in this case is sanctioned by the case of Schillinger vs. Gunther, 17 Blatchf., 66. The case of Hailes vs. Albany Stove Co. is not analogous in its facts."

In Libby vs. Glass Co., 26 Fed. Rep., 757, the Court says: "The claims of the patent are as broad as the specification, and are not limited to any particular compound. Since bringing suit, the plaintiff has filed a disclaimer under the statute, in which he limits his claim to the gold ruby compound. This the plaintiff had a right to do. Under the authorities cited by the plaintiff, this was a patent where a part could be properly disclaimed. It did not require the importation of anything new into the specification, but simply the elimination of a part of what was originally claimed."

See also Silsby vs. Foote, 20 How., 386; Hall vs. Wiles, 2 Blatchf., 194, 198; O'Reilly vs. Morse, 15 How., 62, 121; McCormick vs. Seymour, 3 Blatch., 209, 222; Seymour vs. McCormick, 19 How., 96, 106; Singer vs. Walmsley, 1 Fish., 558, 574; Terry Clock Co. vs. New Haven Clock Co., 4 Ban. & A., 121; Christman vs. Rumsey, 17 Blatchf., 148, 160; Coburn vs. Schroeder, 19 Blatch., 377, 380; Burdett vs. Estey, 19 Blatchf., 1, 7; Atwater Co. vs. Beecher Co., 8 Fed. Rep., 608, 610; Tyler vs. Galloway, 20 Blatchf., 445, 447; Gage vs. Herring, 107 U. S., 640, 646; Brush vs. Condit, 22 Blatchf., 246, 254; Matthews vs. Spangenberg, 20 Blatchf., 482; Sessions vs. Romadaka, 21 Fed. Rep., 124; Dunbar vs. Meyers, 94 U. S., 187; Union Met. Cat. Co. vs. U. S. Cat. Co., 112 U. S., 624.

The law, as established by the foregoing authorities, permits the complainant to save what was really Faure's invention. The defendants, in opposition to this view, rely upon Hailes vs. Albany Stove Co., 17 Fed. Rep., 542, affirmed 123, U. S. 582.

There seems to be a clear distinction between that case and the one at bar. In that case there was nothing in the specification to indicate to the public that the invention of the patentee was what he sought to make it by the disclaimer. He claimed "a perforated fire pot," etc., and when he found that this was old he sought by disclaimer to limit his invention to a particular kind of fire pot described for the first time in the disclaimer. At page 587 the Supreme Court say: "A disclaimer is usually and properly employed for the surrender of a separate claim in a patent, or some other distinct and separable matter, which can be excluded without

mutilating or changing what is left standing. Perhaps it may be used to limit a claim to a particular class of objects, or even to change the form of a claim which is too broad in its terms, but certainly it cannot be used to change the character of the invention.

"And if it requires an amended specification or supplemental description to make an altered claim intelligible or relevant, while it may possibly present a case for a surrender and reissue, it is clearly not adapted to a disclaimer. A man cannot, by merely filing a paper drawn up by his solicitor, make to himself a new patent, or one for a different invention from that which he has described in his specification. That is what has been attempted in this case. There is no word or hint in the patent that the invention claimed was a firepot with sides grated only half way, or part of the way, from the bottom towards the top, or that such partially grated sides have any advantage over those grated all the way to the top. The first claim as modified by the disclaimer has nothing in the specification to stand upon, nothing to explain it, nothing to furnish a reason for it."

The decision states no new law, it is entirely in line with the other authorities cited. Instead of forbidding it would seem to sanction a disclaimer in the case at bar. The facts here and in the Hailes case are wholly different. Hardly one of the criticisms upon that disclaimer would apply to a properly drawn disclaimer here.

The part of the invention which, *bona fide*, belongs to Faure is an electrode in a secondary battery consisting of a support coated with an insoluble layer of active material in the form of a paint, paste or cement, so as to be or become instantly spongy, etc. It was this that the scientific world recognized as a great discovery of great merit and importance. It was this that the distinguished Scotch electrician regarded as "marvelous." And this was the result of Faure's genius. No one anticipated him. It is honestly his. What he did not invent was an electrode in a secondary battery coated with a soluble layer of active material; neither did he invent an electrode on which the active material is applied by "galvanic action or chemical precipitation, or otherwise." The claim is broad enough to cover all these forms probably, and some of them certainly. What he is not fairly entitled to he wishes to give up, and keep what is certainly his own. He does not seek to broaden his patent, but greatly to restrict it. No one will infringe unless he constructs his battery in the one way to which the patent will be confined. This is the patentee's way, and it has many distinguishing characteristics which differentiate it from the ways pointed out by others. The matter to be relinquished is distinct and separate and can be exscinded without mutilating what is left. No amendment is necessary. The claim read in the light of the description is too broad. It is sought to limit it. The disclaimer suggested will not make a new patent or a different invention. The invention is fully described in the specification, and the limited claim will stand on that description.

After giving the subject the most careful consideration it is thought that Faure was the originator of the invention just described, and that it would be unjust to him to declare the patent wholly void if he is willing to restrict it to what is lawfully his own.

The fourth claim, if construed to cover the defendant's structure, is void for want of novelty. It is for a combination containing the following elements:

First—A secondary battery.

Second—A series of cells.

Third—In each cell a pair of electrodes with an active spongy layer thereon.

Fourth—Non-porous partitions between adjacent cells.

The specification declares that "Secondary batteries, like ordinary galvanic batteries, can be made with a series of cells side by side, or one above the other, with the intermediate walls common to the two adjacent cells. In making such batteries it is advantageous, and in some cases essential, to apply a non-porous partition of rubber or other suitable substance to the plates so as to cut off all communication between the cells. This combination of non-porous diaphragms with the electrodes in such secondary batteries constitutes a portion of the invention."

In other words, the claim, if not limited to the peculiar construction shown in the specification and drawings, is for placing the electrodes of a secondary battery in an old form of cells. One of the expert witnesses for the complainant says, "I understand that the series of cells described in the fourth claim of this patent is simply the series of cells of the Cruikshank trough battery transferred to or used in a secondary battery." Another of the complainant's experts testifies that, in his opinion, "the claim covers substantially the use in a secondary battery of the well-known trough divided into cells by non-porous partitions long used in primary batteries, and in which Faure has replaced the primary battery electrodes by the secondary battery electrodes of his own construction." And, again, he says, "The specification described one way in which the elements of the combination may be constructed, and the language of the fourth claim is broad enough to cover not only that specific construction, but any other construction, substantially the same by which substantially the same result is obtained."

Upon the statements of the patent itself, without having recourse to the many structures which the record discloses, containing a series of cells, no novelty can be maintained. It is to be observed that the claim is not necessarily confined to the Faure electrodes.

After reading the specification, it may with plausibility be maintained that the patentee was of the opinion that invention was involved in doing, in a secondary battery, what had previously been done in a primary battery. He wished to claim a series of well-known cells when applied to a secondary battery. The claim covers, in a secondary battery, a series of cells, comprising each a pair of electrodes, with an active spongy layer thereon. It is broad enough, therefore, to include the electrodes of Planté, and of others, as well as of Faure. An electrician who should place a series of Planté's couples into a trough like Wollaston's, for instance, divided into cells by diaphragms, would infringe. But there is obviously no patentable novelty in such an arrangement, especially in view of the fact that Planté had employed almost the identical combination. In the description memorandum of his patent (No. 78,897), Planté says: "If it is desired to connect several elements in series, these plates themselves can serve as the walls of the contiguous troughs just as in the Cruikshank voltaic battery."

With the information derived from the prior art before him; the arrangement of the claim would have been obvious to a neophyte in electricity. It is not often that a single-cell battery is utilized in the arts. When a battery of more power is needed the convenient but obvious feature of the fourth claim would suggest itself to any one who has sense enough to economize time, space and money. Even if the claim could be limited to Faure's electrodes there would still be nothing of which to predicate patentability. A mere aggregation of cells, with no result except such as is derived from multiplication, is not sufficient. If Faure had omitted the fourth claim and all reference thereto in the specification, no one else could have obtained a patent for a series of Cruikshank or Wollaston cells containing Faure's electrodes. Neither can Faure. No matter how ingenious a device may be there is usually no more of the inventive faculty displayed in placing it in a known series than if it were of the simplest character. Invention cannot be asserted for the aggregation, because of the novel character of the segregated structures. There is no more ingenuity displayed in placing Faure's electrodes in a well-known trough than in placing there the electrodes of some one else. His invention was for a new electrode in a secondary battery. This he is entitled to, but he is not entitled to claim as new a well known construction of cells because he puts his new electrodes into them. It is clear that a construction of the claim which is broad enough to cover the defendant's battery renders the claim invalid.

Bush vs. Fox, 28 Law and Eq. Rep., 1; Holmes vs. The Electric Company, 33 Fed. Rep., 254; Hailes vs. Stove Company, 123 U. S., 586; Heating Company vs. Burtis, 121 U. S., 296; Railroad vs. Truck Company, 110 U. S., 490; Boudoir Car Company vs. Monarch Car Company, 34 Fed. Rep., 190.

A limited construction can, however, be given the claim which will render it valid. The defendant's expert insists that the claim must be confined to a combination in which the electrodes are combined with non-porous partitions between adjacent cells by being applied thereto. The manner in which this is done is described in the specification. It says: "Fig. 6 is cross-section of an electrode with non-porous partition, having the prepared plates secured on both sides, and adapted for use in a battery with series of adjacent cells. * * * It shows the arrangement of parallel plates formed with an interposed wooden board *x*. This arrangement permits of employing thin sheets of lead, while securing at the same time sufficient stiffness, and affording means of firmly securing the parts *x* without any leakage between the adjacent cells formed on each side of the leaden plate *a*." The specification further states that when the supporting plates are to be placed either parallel or in any other position permitting of their being distorted by mechanical strain, stiffness may be imparted by applying them on wood or hard rubber non-porous boards so as to prevent any liquid passing from one cell to another. The boards of these compound supports have edges fitted with India rubber in order to render the cells perfectly liquid tight.

It is argued with force and plausibility that it was the intention of the patentee, as shown by these extracts from the specification, to cover only his special construction, the novel feature of which is the non-porous partition with which the electrodes are combined and to which they are applied. It is asserted that this intention is rendered more certain by an examination of the file wrapper where it is still more clearly disclosed, and that nowhere in the specification is there a description of the apparatus as constructed by the defendants. In view of these facts and because the patentee, in effect, disclaimed the construction sought to be placed upon the claim by the complainant, it would seem that the defendants' construction has much in reason and authority to support it and is the more rational of the two.

So construed the defendants do not infringe the claim.

The patent granted to Joseph Wilson Swan, Feb. 17, 1885, No. 312,599, is for an improvement in secondary batteries. The application was filed Jan. 18, 1882. The object and aim of the patentee was the production of plates having surfaces more suitable for holding the active material. In carrying out this idea he prepares plates with perforations, cells or holes extending through the plates in which the active material is packed. He says: "It should be understood that the form of the cells may be greatly varied without departing from the principle of my said invention, the object being to obtain an interstitial construction of plate capable of affording a very large amount of acting surface in a small compass, and to prevent the coating of oxide or spongy lead from falling away from the plate, as it would from a plain vertical surface, unless held in position by some material external to the said coating."

The claim is:

"A perforated or cellular plate for secondary batteries having the perforations or cells extending through the plate and the active material, or material to become active, packed in the said perforations or cells, substantially as described."

The specification states that the patentee has obtained a patent in Great Britain for the same invention, dated May 24, 1881. It is argued that this allegation carried the invention back to the date of that patent although the patent itself has not been introduced in evidence. No authority is produced to sustain this contention. Being a mere declaration, unsupported by proof, it is thought that it cannot be accepted as the date of the invention, which, in the absence of other proof, must be taken as of the date of the application, January 18, 1882.

The advantages of a plate so constructed are well summarized by Sir William Thomson. He says: "The making of the support plates perforated to receive the active oxide has great advantage over making them with mere grooves or roughenings, because it supersedes the necessity for felt or cloth to prevent the active material from falling off. * * * I have found the oxide very liable to crack away and fall off when merely placed in grooves or pressed into hollows of a roughened plate. When pressed into perforations they remain very securely attached, forming as it were 'rivets.' * * * Even with bad usage it is a rare accident that one of the oxide 'rivets' breaks and falls out. The perforated plates have also the great advantage of extending the area of electric communication between the continuous metallic conductor and the spongy or porous material, and so minimizing the electric resistance. The application of the oxide in the form of numerous mutually detached parts separately held by the perforations had also a great advantage in almost annulling the warping or fracturing effects of the expansion and contraction produced by the changes of oxidation to which the active material is exposed in the charging and discharging of the battery."

In view of these facts there is no difficulty in deciding that an electrode so constructed was patentable. The invention is a simple one, but something more than mechanical skill was required.

Indeed, the experts on both sides agree that an electrode so constructed has marked and peculiar advantages.

It is insisted that the patent as issued is an unlawful expansion of the original application and, therefore, within the rule of Railway vs. Sayles, 97 U. S., 563. The argument is based upon the assumption that in the original specification the patentee nowhere describes electrodes with perforations extending through the plates and that it was not until March 24, 1882, that he mentioned a perforated plate. The complainant denies this and asserts that Figs. 1 and 2 in the patent, as issued, are identical with these figures in the original drawings. Positive proof of this statement has not been found, but the presumption that it correctly states the fact is very strong. The original specification states that:

"The plate shown in Figs. 1 and 2 is constructed with cells or cavities *a* for the reception and retention of spongy lead. * * * The cells may be closed on one side as shown at *c* in Fig. 2*a*."

The only rational construction would seem to be that as the last figure showed the cells closed on one side the two others showed them not closed, but open through the plate.

It must also be assumed that the officials of the Patent Office performed their duty, and did not permit a fraud to be perpetrated by the alteration of the drawings. There is absolutely no proof that such alterations were made, and, if the memoranda of the file wrapper can be relied upon for any purpose, they show that the original drawings were in the office at the time the claim for a perforated plate was presented, and long afterwards.

The question, therefore, is whether there is anything in the act prior to Jan. 18, 1882, which anticipates the claim or renders it invalid.

The English patent, granted to John S. Sellon, does not anticipate, for the reason that though dated Sept. 10, 1881, it was not sealed until March 10, 1882, after the filing of Swan's application. It was not made patent to the public, therefore, until March 10, 1882.

Smith vs. Goodyear, 93 U. S., 486–498. Bliss vs. Merrill, 33 Fed. Rep., 39, 40. Siemens vs. Sellers, 123 U. S., 276–283.

But the evidence of Prof. Asahel K. Eaton, if it does not amount to a complete anticipation, so narrows the field of invention that nothing remains of which to predicate patentable novelty. It is thought, however, that as to some of the electrodes made by him there can be no doubt that they fully anticipate Swan's claim. If made now for the first time they would infringe; being made before the application, they anticipate.

Cook vs. Sandusky Tool Co.- 4 Sup. Ct. R., 4, Peters vs. Active Mfg. Co., 21 Fed. Rep., 319; affirmed, Sup. Ct., Mch. 5, 1889.

Prof. Eaton testifies that in 1881, and certainly prior to August, 1881, he made experiments in secondary batteries, using perforated lead plates for the electrodes. He finally adopted them, considering them preferable to others tried by him. These plates were perforated by means of a belt punch, which cut out small discs varying from a quarter to five-eighths of an inch, according to the size of the plates. Lead sponge, previously prepared, was then precipitated upon both sides of the plate, so as to cover both surfaces and fill the perforations. He says: "I afterwards adopted one of the methods which I had tried, where I used two perforated plates with the sponge deposited upon one or both of them and the two plates put together so as to retain the sponge between them, the sponge filling the perforations. This made one electrode. The other electrode was made with two similar perforated plates, the peroxide being made into a paste with sulphuric acid and water, and pasted upon each side of a piece of asbestos. This was put between the two perforated plates and pressed down so that the paste covered the whole surface of each half plate and filled the perforations. Some of these plates were perforated so as to leave a burr projecting in one direction, which aided in the retention of the paste, the two burred surfaces being outside. This provided an enlarged cellular cavity.

In July, 1881, he made another battery with the assistance of one George Farrington, who corroborates him in part as to its construction. This battery was made by spreading the described paste upon either cloth or asbestos and enclosing it between two perforated plates of lead. The perforations, in the absence of a proper tool, were made with a knife. This formed one element. The other element was made by precipitating lead sponge upon one surface of a similarly prepared plate and covering it with another plate, so as to make one, folded together at the edge. The paste was minium mixed with sulphuric acid and water. This paste filled the perforations in the plates.

Prof. Eaton also made electrodes by coating with a similar paste a frame work of woven lead wire. The batteries thus constructed by him were charged and worked successfully. Besides Farrington, he is corroborated by Mr. Sleeper, who assisted in the construction of the batteries of August, 1881, by punching holes in regular order in the leaden plates. And Sleeper is, in turn, corroborated by entries made at the time in his diary, which also contains rough drawings of the perforated leaden plates. No evidence is offered by the complainant which at all conflicts with the verity of these statements. As before observed, the Court is not permitted to reject the evidence of unimpeached and respectable witnesses, when they are corroborated, and there is nothing to cast a doubt upon the truth of their statements. Upon this evidence, therefore, the first Swan patent must be declared invalid.

The second patent granted to Joseph Wilson Swan is dated May 26, 1885, No. 318,828. The application was filed May 3, 1883. The claim is as follows:

"In a battery plate or electrode composed of a conducting support combined with active material, the support in the form of a plate with angular or equivalent holes, cells or perforations extending through the same, and separated from one another by webs, walls or partitions of uniform cross-section, the active material being placed in said holes, cells or perforations, substantially as set forth."

This would seem to be for the same subject matter covered by the first patent of Swan. It is conceded that the alleged invention is described and shown in the first patent. The only difference suggested is that the second patent is for a more limited subdivision of the same general invention. The patent in the specification states:

"It should be observed that I do not claim herein, broadly, the use of plates provided with holes or perforations extending through the same, and having the active

material, or material to become active held in such holes or perforations, as this forms the subject matter of patent granted to me on the 17th day of February, 1885, numbered 312,599."

One of the complainant's experts after stating his understanding of the first patent says of the patent in hand: "It has a specific claim, a claim rendered specific by its limitation to uniform webs, walls or partitions separating the perforations from each other." Another of the complainant's experts says that his understanding is that the second patent covers plates or electrodes such as are described in the first patent, "with the additional limitation that the webs, walls or partitions between the cells shall be of substantially uniform cross section."

It will be observed that the drawing of the first patent shows a plate made in exact accordance with this limitation and the specification states that the form of the cells may be greatly varied without departing from the principle of the invention. Even if the second patent can be distinguished from the first in the particular stated by the experts it is entirely clear that the difference pointed out is wholly insufficient to sustain invention. After the first patent there was absolutely no room for a second patent; which, upon the most favorable construction for the complainant, simply claims an arrangement which any one who had sense enough to make the perforations at all would most certainly adopt. When a patent has been granted for a plate containing rows of holes, another patent cannot be granted for the same plate containing *uniform* rows of holes. Neither can there be anything patentable in the mere shape of the holes. A patent for a device containing round holes will preclude a subsequent patent for the same device with square or triangular holes. Bung Mf'g Co. vs. Bung & B. Co., 31 Fed. Rep., 76, 79

Especially is this so when the applicant is confronted with his own express declarations that the shape is wholly immaterial.

It is not necessary to consider whether a valid patent can be obtained for an invention described, but not claimed, by the applicant, in a prior patent issued to him; the application for the second patent being filed before the first patent issues. That is not this case. Swan describes no invention in the first patent which is not covered by the claim of that patent. What is not claimed is not patentable.

It follows, therefore, that the complainant, upon filing a disclaimer, limiting the first claim of the Faure patent to an electrode of a secondary battery to which the active layer is applied in the form of a paint, paste or cement, insoluble in the electrolytic liquid, is entitled to a decree for an injunction and an accounting upon the claim as thus limited, but without costs.

The Meaning of the Coxe Storage Battery Decision.

It has been claimed that the decision of Judge Coxe last week, gives recognition to the broadest claims in this field of Mr. Charles F. Brush. Deeming the matter of sufficient importance we have called upon Messrs Witter & Kenyon, who are the counsel for the Brush Electric Company. Below is a summary of the views they express:

"A copy of the opinion of the United States Circuit Court for the Southern District of New York in the case of the Electrical Accumulator Company vs. the Julien Electric Company has been received by us and examined.

"The court recognizes Charles F. Brush, of Cleveland, Ohio, as legally entitled above all others to be considered the first inventor of secondary batteries in which the active coating is mechanically applied. This view is in accord with and confirms the action of the United States Patent Office, which granted to Mr. Brush, March 2, 1886, after a contest with C. A. Faure and others, the Brush patents covering such secondary batteries, which is the class of secondary battery now in general use, as well by the above-named litigants as by others. The above suit was brought by the Electrical Accumulator Company upon four patents, one patent to Shaw & Rogers, one to C. A Faure, and two to J. W. Swan. The first patent was withdrawn by the plaintiffs from the litigation and given up; the two Swan patents were declared to be invalid in the decision of the court; of the two claims of the Faure patent sued upon, one has been declared to be invalid, if broad enough to be infringed, and the other has also been held to be invalid in its present form. The court has pointed out that if the Faure people disclaim all right to anything except one particular way of applying the coating, to wit, by 'paint, paste, or cement,' and limit the patent to that narrow and restricted species of secondary battery the court can sustain such a claim. The court having held all the claims declared upon by the plaintiff to be invalid, awarded no costs to complainant.

"As by this decision Brush is shown to be legally the first inventor of a secondary battery having a mechanically applied coating, it is apparent that the greatly restricted claim which upon condition of making the disclaimer, is allowed the Electrical Accumulator Company is subordinate and subject to the Brush patents of March 2, 1886.

"The defendant in this case introduced a large number of prior publications and patents as anticipating the invention. Judge Coxe has spent a great deal of time and labor in examining carefully all these prior matters, and has discussed them at great length in his opinion. After a full and very able consideration of these publications, he holds that they do not show a secondary battery having a mechanically applied coating, and do not anticipate this invention.

"We are informed that the defendant, the Julien Company, does not now apply its coating in the form of paint, paste or cement, and will, therefore, not become tributary to the Faure patent, even if the disclaimer above alluded to be filed."

The Electrical Accumulator Company and the Coxe Decision.

The following has been issued by President D. H. Bates, of the Electrical Accumulator Company:

Judge Coxe has just rendered a decision in the United States Circuit Court for the Southern District of New York sustaining the Faure patent for improvements in secondary batteries or accumulators. The patent is held to cover and control the manufacture, use or sale of any secondary battery in which an electrode is used having the so-called active material applied in the form of a paint, paste or cement, which is the only method yet known of constructing a practically operative secondary battery.

The suit is entitled the Electrical Accumulator Company *vs.* Julien Electric Company, and the complainant is entitled to an injunction, which will now be taken.

With the exception of the recent decision of the U. S. Court for the District of Massachusetts sustaining the Thomson-Houston patent for an arc light current regulating device, the Faure patent above alluded to is the only electrical apparatus patent pertaining to lighting or motor business, the litigation on which has terminated favorably to the claims of the patentees.

The field for accumulators is very large, as shown by the fact that there are to-day no less than eight or ten companies engaged in that business. Among them are: The Electrical Accumulator Company, owning the Faure patents; and the Julien, Gibson, Woodward, Pumpelly and Macraeon companies, all of whose batteries are tributary to the Faure invention.

In anticipation of a favorable decision the Electrical Accumulator Company has already built a street car to be propelled by means of batteries, and now has it on exhibition on Elkins & Widener's Philadelphia traction road in West Philadelphia. Its initial trip last Friday was a great success, the car moving up a long five per cent. grade at the rate of seven miles an hour. Brill & Co., West Philadelphia, are making six other cars to be completed in April and May, and the Electrical Accumulator Company, believing that it controls the use of secondary batteries in all known practical forms, is now prepared to occupy extensively the electric street car field.

New York Board of Electrical Control.

The Board met on the 19th. inst. The application of the Municipal Electric Power Company for a franchise, and also for subways in First, Second and Third avenues, from Eighty-sixth street to the Harlem River, was referred to the engineer of the Board.

A letter was read from Alderman Walker asking that all subway work on Hudson street, from Chambers street to Fourteenth street, should be completed before the road is repaved. The Board considered that the subway which has been built in Hudson street, from Worth to Canal, would meet all requirements for several years to come.

The Western Union Company asked for permission to erect six new poles on St. Nicholas avenue, between One Hundred and Thirtieth and One Hundred and Fortieth streets, to replace rotten and dangerous poles. The company has a line of leased poles on the other side of the avenue, and the Board directed that on these the wires shall be placed, and the dangerous poles shall be removed.

Several other applications were presented, but the Mayor resolutely declined to entertain them for the present. A letter was read from Mr. W. Allison recommending to the Board the services as electrical expert of Dr. P. H. Vander Weyde. The Board thought that in view of the perfect confidence it has in the present efficient expert, Dr. S. S. Wheeler, it would not desire to avail itself of the services of the veteran doctor.

The Metropolitan Telephone and Telegraph Company was ordered to remove one of its two lines of poles in Water street, and the Western Union was notified that one of its two lines in Hudson street must be immediately removed.

A report was received from the engineer of the Board suggesting that in addition to work not completed last year, new subways for electric light and power should be placed on the east side of Sixth avenue from Fourteenth to Eighteenth streets; on the west side of Sixth avenue from Fourteenth to Twenty-fourth streets; on the south side of Fourteenth from First to Sixth avenues, and in Twenty-ninth street from Fifth to First avenues. He also recommended the construction of subways for telephone and telegraph service through Murray street from College place to Broadway; Centre street from Worth to Grand streets; East Houston street from Crosby to First avenue; Thirty-eighth street from Lexington to First avenue; Seventy-ninth street from First to Park avenue, and Lexington avenue from Sixty-fifth to Seventy-ninth streets.

It was resolved that the report of the engineer relating to new work be approved, and the secretary of the Board be asked to communicate with the Construction Subway Company to proceed with the work as rapidly as possible.

Mr. Moore, of the East River Company, wished to make a statement with regard to an application which had been presented to the Board, but the Mayor declined to hear him. Mr. Moore was explaining that the application was of importance to the public as well as to the company, when the Mayor "jumped on" him, and said that to be in order Mr. Moore must address the Board in writing. The meeting then adjourned, subject to the call of the chair.

Street Railways to be Equipped with Electric Motors.

We are informed that during the last week the Sprague Electric Railway and Motor Company, of New York, have closed several important contracts in railway work in New England and in the West. One of these is with the Marlborough, Mass., Street Railway Company. Part of this is double track and part single. Before deciding upon any system to be used upon their railway, which is a new one, having never been operated before by any kind of power, the committee in charge of this visited a number of cities where there are street railways in operation and investigated their workings. The result of the tour of inspection was that the committee gave the contract for equipping the road to the Sprague Company, who will immediately enter upon the construction of the overhead work. The contract calls for the regular Sprague overhead system and latest type of motors.

Another contract closed by the Sprague Company for the street railroad equipment is in Wichita, Kan., where 7½ miles and four cars will soon be running by electricity upon this system. The improved 15 h. p. motors will be used and the equipment will be first class in every respect.

Another street railway company to adopt electricity as a motive power is that of Eau Claire, Wis. We are informed by the Sprague Company that this contract calls for the furnishing of six cars and over five miles of track. The regular Sprague overhead system will be used, employing a small No. 6 wire as a working conductor, no larger than an ordinary telephone wire, which is the only wire suspended over the track. Before deciding to adopt electricity in general or any particular system, the president and managers of this road visited a number of electric railroads in operation in the east and other parts of the country. As a result the decision was unanimously in favor of electricity and the construction upon the road will begin immediately.

Special Correspondence.

NEW YORK NOTES.

Office of The Electrical World,
168-177 Potter Building, New York, March 25, 1889.

The Western Electric Company will soon be in the enjoyment of their new and handsome building. It has 12 stories presenting an imposing front. All the departments are remarkably large and complete and special facilities have been provided for the receiving and shipment of goods on the two streets. As I looked in the other day I saw that the lower floors were lighted up with the well-known Western Electric arc system, presenting a very cheerful and animated scene.

The Backus Water Motor Company, of Newark, N. J., are well known in their special line of production, their water motors being used for driving sewing machines, as well as for apparatus requiring several horse-power. These motors are valuable when a good pressure of water can be procured in town or country for driving small dynamos. The company also make the well known Backus patent fan, which should have a large demand this summer in connection with small electric motors for keeping rooms and offices cool, as well as for ventilating purposes.

Hanson, Van Winkle & Co., the noted makers of electro-plating supplies and of the popular Little Wonder dynamo plating machine, at Newark, N. J., tell me that they have over 1,000 of these machines in use at the present time. They are said to be the largest makers of nickel platers' supplies, lacquers, etc. Their salesrooms, 95 Liberty street, N. Y., are fully equipped with all their various specialties. The headquarters at Newark are particularly well equipped, and give an idea of the extensive nature of their business, as it includes a full line of electrical supplies for the house, office, etc.

The Priestman Petroleum Oil Engine is being run at 106 Washington street, this city, in conjunction with one of Mr. C. L. Levey's self-regulating dynamos for simultaneous arc and incandescent lighting. The machine is shown running 25 16 c. p. lamps at 45 volts, ¾ of an ampère, in five separate circuits from one binding post, with separate switches on each. These switches are only necessary when it is desired to cut out any of the circuits. It has also a switch on the top of the dynamo to cut out one and all of the circuits. The engine runs very nicely and prettily and seems well adapted for isolated plant work of this description. Mr. C. L. Levey has what he calls his "cottage," "villa," "suburban mansion" and "manor" plants, which he furnishes complete.

Straight Line Engines.—Mr. F. H. Hayward, who represented the Armington & Sims engine in the West, and made quite a reputation there, is meeting with his old success here in the installation of the Straight Line engines with Messrs. Williams & Potter, 15 Cortlandt street. Mr. Hayward has made a specialty of high speed engines, and is thoroughly acquainted with the requirements of electric light stations in the equipment of their power plants. A large number of Western stations bear witness to his good work. I understand that the Straight Line engine will be represented at the Paris Exposition by five engines, two of which are now on the way. The others would be shipped at once but for the fact that the demand is far beyond the producing capacity.

The Safety Electric Construction Company, J. Murray Mitchell attorney, 41 and 53 Wall street, this city, furnish estimates for the complete construction of electric railways and supplies of all kinds, as well as for the full equipment of power plants. This company are also the sole manufacturers of the Creamer automatic steam pump trap, the claims for which are a material saving of fuel and water and the stoppage of all noise. This noise, as many of your readers are probably aware, is the unpleasant hammering so frequent in steam radiators, and this trap will overcome the nuisance. It will force the water of condensation from the exhaust in engine or heat pipes with greater ease and convenience, it is claimed, than in any other trap or contrivance in the market.

Electric Club Officers.—At a meeting of the New York Electric Club held on Thursday evening, March 21, the following gentlemen were nominated for officers for the ensuing year: For president, E. T. Gilliland, O. E. Madden. For vice-presidents, E. T. Gilliland, T. N. Vail, H. C. Davis, E. N. Dickerson. For secretary, Charles W. Price. For treasurer, Willard L. Candee. For board of managers, H. D. Stanley, M. W. Goodyear, Geo. B. Coggeshall, C. O. Baker, Jr., C. W. Gould, H. L. Storke, A. H. Patterson, H. A. Reed, C. W. Spear, E. M. Hamilton, S. D. Field, C. E. Stump, Geo. M. Phelps. For committee on membership, Henry Hine, chairman Geo. T. Manson, George Worthington, Lieut. F. W. Toppan, U. S. N., J. J. Carty. The election will take place in April.

The Smith and Shaw Pocket Battery.—Mr. Henry Schwindt, of 435 Seventh avenue, is manufacturing the Smith & Shaw closed cell pocket battery. This little battery embodies a great many improvements, is very effective and economical, and has remarkable portability and convenience. Battery No. 1 is only 6 inches long, 3¼ wide, and 1¼ high, outside measurement, and No. 2, containing two cells, is 7¼ inches long, 3¼ wide and one-half high. There is no danger or possibility of the spilling or slopping of the battery fluid and the current which is delivered is of fine, smooth quality. Mr. Schwindt has a large number of testimonials from those who have used or dealt in the battery, including medical men, and such well-known firms as C. E. Riker, Ga Nun & Parsons, A. S. Aloe & Co., Bullock & Crenshaw, and others.

The Standard Underground Cable Company are always very busy receiving, filing and mailing orders to the works. Dropping into Mr. Wiley's office the other day, in 18 Cortlandt street, I found him with his usual smile attending to the receipt of a couple of orders for 15,000 feet of two conductor telegraph cable, and 17,000 feet of one conductor cable for overhead electric light service. The company have been using P. & B. compound in connection with their braided fibre protector for the lead covering on 31,000 feet of No. 4 B. & S. stranded wire conductor now underground and being jointed for the United States Illuminating Company, and 4,000 feet of No. 4 for the Manhattan Electric Light Company, which has been put under ground, and is being jointed. These orders have been taken since the first of the month, with some 27 others of various sizes, including one for 10,000 feet of 00 conductor for the United Electric Light Company, of Springfield, Mass.

The Simplex Electrical Company are represented in this section by Mr. A. W. Butterworth, who reports trade in excellent condition. The demand for the specialties of the company is excellent, and the testimonials which are given are of a very striking and convincing nature. The neat little pamphlet which is issued by the company, and of which Mr. Butterworth gave me a copy,

contains a number of very warm testimonials from users of the Simplex wire. The company also handle an insulating tape, and have a neat little specialty in their tree insulator by means of which the wire passes between two glass insulators, revolving upon iron legs so that the swing of the tree limb simply moves the insulator along the wire without injuring the covering. It stands to reason that wherever such insulators are in use the toilsome lineman will not have to spend his nights hunting up "grounds" in trees, and the superintendent of the electric light company will be able to sleep in the bosom of his family undisturbed by wild alarms.

Mr. F. R. Chinnock, well and favorably known to the writer, no less than to the electrical public in general, has been very successful of late in securing large contracts for the Edison system in the district which he controls,—Long Island and New Jersey. He seems of late to have been particularly successful with the big refineries. He has just closed a contract for a large Greenpoint refinery for a thousand lamps of 16 c. p. This plant will be a model installation in all respects. It will be run by two 500 light dynamos and will also comprise a 5 h. p. motor, which will carry the bags of sugar from the steamship up to the refinery door. Steam motive power will also be furnished by Mr. Chinnock and will consist of two fine engines 12 × 12. The dynamos are to be self regulating. Mr. Chinnock has also closed a contract for an 800-light plant for a central station to light the village of Bay Shore, L. I. This plant will be installed on the 3-wire system. The streets will be lighted by the Municipal system. Mr. Chinnock is further installing two plants for the Pennsylvania Annex boats.

The Elektron Manufacturing Company, of 150 Nassau street, are quite busy. Mr. E. H. Cutler, the manager, says: "The demand for our motors and dynamos exceeds our expectations. Besides the sales for commou uses, we have recently made the following sales to well known people, who, it will be seen at a glance, are thoroughly competent to judge of the merits of a machine and are discriminating in their choice: One ⅙ h. p. motor to the Physical Laboratory of the University of Michigan, Ann Harbor, Michigan; two 1-6 h. p. motors to Stephen D. Field; two ⅙ h. p. and two 1-6 h. p. motors to Thomas A. Edison. These machines will be used to drive working models and light machinery in the large exhibit which Mr. Edison will make at the Paris Exposition. Two ⅙ h. p. motors to the Postal Telegraph Company. One of these will be in use in Chicago, and one in New York City, for driving the apparatus of the American Machine Telegraph System. One 1 h. p. motor to the Western Electric Company, Chicago, Ill."

The Manhattan Electric Light Company are pushing forward work on their station at Eightieth street and Avenue B, where they have a fine large brick building. A great deal of apparatus is already on the ground, including Slattery alternating current machines, but with so large a plant it will be some little time before the whole can be put into order and operation. The plant will be distinctively of the Fort Wayne Jenney type, although a Brush 60-lighter will be temporarily used for arc circuits, pending the installation of the special new 2½ ampère Fort Wayne machines. The company have already run ten circuits to Seventeenth street, twenty-six to Sixty-third, four to Fourth street, and cross wires are already up on Twenty-eighth and Fourteenth streets. The company has every prospect of doing a large business, and has already secured contracts for lighting Palmer's Theatre, the Star, the Bijou, Proctor's and Turner's, the new Union Square and, I believe, Daly's. This in itself would mean a large amount of business, but it is a very small proportion of that which the company proposes to do.

The Goubert Manufacturing Company and the Stratton Separator Company will move from 18 Cortlandt street to 32 by the 1st of May. They have put in for the Western Electric Company's new building a 500 h. p. feed-water heater; a 300 h. p. for the West Side Electric Light and Power Company; a 600 h. p. for the Daft Electric Power Company, of Newark, and a 250 h. p. for the Edison Electric Illuminating Company, of Albany, N. Y. A 250 h. p. has been put into the new Brooklyn factory of Mr. J. J. Wood, where that well-known electrician is preparing to bring out a new system of electric lighting apparatus. At the Sprague electric railway station, Scranton, Pa., recently illustrated in your columns, a 400 h. p. heater has been put in. One of 150 has been supplied for the Statue of Liberty, and the Patchogue Electric Light Company, of Long Island, has also been equipped. Some of the plants mentioned are also using the well-known and efficient Stratton separator for furnishing dry steam to the engines. It is evident that both these specialties are in active demand, engineers appreciating the saving both in water and steam.

Platinum Wire.—I am sorry to report that Mr. C. O Baker, Jr., who is so deservedly popular in electrical circles, has not been able to attend to business for several days, owing to illness. His company at Newark have been enlarging their factory, so that they now have about four times as much room as they enjoyed last year, and they are thus enabled to meet the pressing demands upon them for their various specialties in platinum wire for incandescent lamps, etc. They are now, I believe, beyond question, the largest gold, silver and platinum smelters and assayers in this country. They make platinum in sheet and wire in all sizes and degrees of hardness for lamps, electrical instruments, chemical apparatus, platers, jewelers, dentists, etc. They also supply pure aluminum in sheet and wire for electrical purposes. The history of the development of the platinum industry, as exemplified by such a firm, is one of great interest, tracing the material back to its production in the Siberian mines, and down to the time when it passes through the specially heavy rollers that make the wire and turn it out for such unique work in connection with incandescent lighting.

Compounding High Speed Engines.—Recent developments in the direction of compounding high speed engines are attracting marked attention from steam users as a step in the direction of higher efficiency without sacrificing the recognized advantages of compact power driving direct to dynamos or other rapidly rotating machinery. A new feature in this development which will be watched with interest is the use of this type of compounds without the condenser in localities where cheap water for condensation is not available. It is believed that high steam pressure, expanding through two cylinders, will effect a clear saving that will more than justify the small additional expense of compounding. Acting on this belief, Mr. C. J. Field, general manager of the Edison Electric Illuminating Company, of Brooklyn, and formerly chief engineer of the Edison United Manufacturing Company, has selected this type of engine for the mammoth central station now being erected at 340 Pearl street, Brooklyn, where the energy of 3,000 h. p. will be sent out in electric currents through an underground system radiating through nearly a mile in all directions from the station as a centre. The engines for this work will be furnished by the Ball Engine Company, of Erie, the order having been placed with their New York agent, C. R. Vincent & Co., No. 15 Cortlandt street, for twelve engines each 250 h. p. capacity. The general plan of these engines will be of the double horizontal type with opposite cranks and one high pressure and one low pressure cylinder. Each engine will weigh about 30,000 pounds, thus making twelve full carloads for the engine equipment of this station. Steam will be supplied at 125 pounds pressure by a battery of Babcock & Wilcox boilers, situated on the same floor with the engines. With an electrical outfit embodying all of Mr. Edison's latest improvements in central station work, it is the expectation of the projectors of this enterprise that they will have the most economical and efficient station that has yet been erected.

A Trip to Newark, N. J.—Running over to Newark the other day, I found it all alive and bustling with its many industries, not the least of which are the electrical. The city becomes more and more a manufacturing centre, and every day strengthens its connections with New York. Several new electrical specialty makers have been established since the beginning of the year for the manufacture of dynamos, motors, electro-plating machines, instruments and supplies of all characters. I heard of one new type of plating machine which is shortly to be put on the market, and of which great things are expected. The Weston Electrical Instrument Company, McKinney and High streets, under the supervision of Mr. Edward Weston, the celebrated electrician, have had such a big run on their new voltmeters, which you illustrated recently, that they have to make special arrangements for their production in larger quantities. Mr. Colby, Mr. Weston's assistant, escorted me through the laboratory, which is one of the largest I have had the pleasure of inspecting, and showed me all the various styles of meters that are being introduced. Mr. Colby favored me by pointing out the nature of the various instruments and by making several interesting tests and experiments. He took me also into the separate solid brick building, where all the fine testing instruments of precision are kept, with special precautions for their accurate working. At C. McIntire & Co.'s I found them as busy as possible preparing their new special electrical connectors for conductors of all sizes, including the largest electric light wires. They are meeting with extraordinary success with their new terminals for electric lamps, ceiling cut-outs, dynamos, motors, switch-boards, etc., and deserve immense credit for the good work they have done in abolishing the imperfect connections which have been a nuisance, and the cause of disaster, in the early days of electric applications. Where these terminals have been put in on railroads, on motors and on electric light circuits, they have met with the highest praise, for the economy that they effect in labor, current and profanity. They are said to be far cheaper and more perfect than soldered connections, and every company should use them.

W. T. H.

NEW ENGLAND NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 8, Cook Building, cor. Franklin and Congress Sts.
BOSTON, March 25, 1889.

The Robinson-Foster Electric Company, Boston, Mass., is reported as having purchased the factory of the Hall Type Writer Company at Salem, Mass.

Mexican Telephone.—The annual meeting of the stockholders of the Mexican Telephone Company will be held at the Astor House, New York, on April 10. Transfer books will close March 27, and be reopened April 11.

Electric Lights for Provincetown.—The town of Provincetown, Mass., will soon have electric lights. A local company has been organized with a capital stock of $15,000 with J. D. Hilliard as president, M. N. Gifford treasurer, and J. A. West secretary.

Incandescents for Boston City Hall.—On Friday, March 22, the Committee on Public Buildings of Boston gave a public hearing on the question of placing in the City Hall an electric light plant for furnishing incandescent lights for the building named and for the Court House.

Bell Telephone.—The annual meeting of the American Bell Telephone Company's stockholders will take place in Boston on Tuesday, March 26. It is expected that the election of president of the company to succeed Mr. Stockton will occur at this meeting, and Col. H. S. Russell is already named for the post.

Newport Electric Railroad.—The stockholders of the Newport Horse Railroad Company have voted to increase the capital stock from $50,000 to $75,000 to meet the cost of introducing electric motor power. The directors authorized contracts for cars and for building the road immediately. Work will be begun April 1.

Hill Clutches for Bangor, Me.—The eastern office of the Hill Clutch Works, 18 Cortlandt street, New York, inform me that they have received the order for furnishing the Bangor, Me., Electric Lighting plant with everything in the line of power transmission machinery and with the "Hill" friction clutch pulleys and cut-off couplings. The City of Bangor is certainly assured of good work.

Edison Lights.—Messrs. Paine & Francis, the New England Agents of the Edison United Manufacturing Company are busy making installations of Edison isolated plants in this section. Among the numerous orders recently filled was a 115 (16 c. p.) light plant for the cable steamer "Pouyer-Quertier," and a 300 light plant (2d increase, in all 700 lights) at the factory of the Ludlow Manufacturing Company.

Danvers' Electric Plant Not for Sale.—An advice from Danvers, Mass., under date of March 21, states that at the adjourned town meeting on Wednesday evening, March 20, the Selectmen and Electric Light Committee were instructed to notify the Legislative Committee on Manufactures that negotiations are not pending for the sale of the Danvers electric light plant, as has been stated.

Pettingell, Andrews & Company.—This well-known Boston firm have their hands full of business. New salesmen have been employed and Mr. Andrews found it necessary to get his son to give up a lucrative situation to accept a position in the employ of the firm named. This firm keep a large stock of about everything known in the line of electrical goods and electric light supplies, and sell at manufacturer's prices.

Electric Light vs. Telephone.—The trouble between the electric light and telephone companies going on for some time at Woburn, Mass., in which, it is said, the latter company has been the the aggressor, now looks as if it would be ended by an amicable understanding. Recent advices from Woburn state that on Tuesday night, March 19, and also on the following morning, a meeting between the officers of the companies named was held.

Glass Company Incorporated.—A corporation known as the Cape Cod Glass Company of Sandwich, Mass., has been chartered under the laws of the State of New Jersey, with a capital stock of $50,000, at a par value of $25 per share. The president is Charles W. Spurr, of Boston, and the general manager is Henry F Spurr, of Sandwich, formerly of the Boston & Sandwich Glass Company. Glass is to be manufactured in all its branches at the works in Sandwich, and an office will be opened in Boston.

Woonsocket Waking Up.—The board of aldermen has decided to grant its local street railway company a franchise to substitute electricity for horse power. Woonsocket introduced the first electric cars run in New England, in 1887, but the service was not entirely satisfactory and a franchise was denied, and the service discontinued after a three months' experiment. With the improved overhead system, the aldermen are now willing to grant a full franchise, and the entire system will be equipped as soon as practicable.

Complimentary Dinner.—Mr. Ernest Thurnauer, an electrical engineer in the service of the Thomson-Houston International Electric Company, was the recipient of a complimentary dinner by a number of his business associates at Young's Hotel, Boston, on Wednesday evening, March 20. Mr. Thurnauer left town for New York after the dinner and on Saturday will sail for Paris to take charge of the exhibits of Professor Thomson, the Thomson-Houston International Electrical Company, and the Thomson Electric Welding Company at the Paris exhibition.

Removal of Offices.—The Simplex Electric Company of Boston has removed its offices from 328 Washington street to No. 620 Atlantic Avenue. The Company has leased a suite of extensive, commodious, and nicely situated rooms on the south-west corner of the fifth floor of the building. From the Federal street windows a magnificent view over and beyond South Boston and a part of the Harbor may be had; while from the windows on the Atlantic Avenue side an extended view of that broad thoroughfare is presented. The offices are tastefully furnished; everything is of modern make and of the best.

Lawrence, Mass.—The Edison Company, of Lawrence, Mass., agents for the Edison system in Essex County, have just completed the installation of a 555-light Edison plant for the new Pacific Mill. The work has been done in a first-class manner throughout the entire building, and embraces many improvements over the old style of mill installation. It is divided into twelve circuits, which are controlled entirely at the switch-board, which is in itself a very handsome as well as novel arrangement, giving the most perfect control of the entire plant from one point. It was designed by Mr. C. I. Alexander, a well-known electrician of the company, who had charge of the installation.

An Amusing Incident.—Recently one of the hard workers of the Hub's electrical fraternity was detained at his office until a late hour. It so happened that one of the other tenants who is generally the last person to leave the building, locked the outside door without notifying the busy man (who had no key) up stairs. The consequence was that the belated electrician was compelled to remain in his office until after midnight and would have remained there until morning had it not been his good fortune to discover a rope in the closet, by which he descended to the street. Fortunately also there was no policeman about at the time. The electrical acrobat landed safely, but with bleeding hands, on the Franklin street sidewalk.

Codifying Insurance Rules.—At the invitation of the New England Insurance Exchange the representatives of the construction business in Boston met the fire underwriters and inspectors at the Boston Electric Club's rooms, 7 Park street, for the purpose of discussing the rules of the Boston Tariff Association and the New England Insurance Exchange previous to their codification and revision. It is proposed to issue uniform rules from each board of underwriters. Mr. Barton presided, and Mr. Alex P. Wright was appointed secretary of the meeting. There was considerable discussion, in which Capt. Brophy, Mr. Killecut, Mr. Wright, Col. Hewin, Dr. Mason, Mr. Patterson and others took part. After considerable business was finished the meeting was adjourned to be called again next week.

The New England Electro-Matrix Company is a Maine corporation, capitalized with $1,000,000 in $100 shares. It is a tributary company of the Minneapolis Electro-Matrix Company, and controls the rights of the latter in New England. There is a similar sub-company in New York and another at Cincinnati, which controls the States of Ohio, Kentucky and Indiana. The parent company controls an invention which aims to perform the double service of setting type and impressing it upon cardboard, producing a matrix from which stereotype plates can be cast. There is, in fact, no type set. The cardboard is indented by electrical pressure applied by an ingenious mechanism, which it is not necessary to describe here. The operator uses a keyboard, as the typewriter does, though upon an entirely different principle. It is claimed for the machine that it can be used in all printing establishments and save a large sum of money. Governor Ames and other capitalists, type foundrymen, etc., are investigating the affair, and more or less money is being put into the stock. The Ames Manufacturing Company of Chicopee is to build the machine for the parent and all other companies. Two machines only have been built as yet, but an order has been given for 100. The machines are to cost $250 each, and the rental for all time will be $500. They will not be sold. The charge to users, besides the gross rental will be 10 cents per thousand ems, of which 7 cents will go to the sub-company, and 3 cents to the parent company. It is said by Dr. W. F. Heald, treasurer of the company, that 125 machines would earn 10 per cent. per annum on the New England company's capital, but it is calculated that a much larger number will be wanted in this territory. Mr. C. M. Gage is president of the New England company, and among the directors is Mr. Theodore C. Bates, the Worcester manufacturer and capitalist. All of the stock of the New England company has been subscribed, and the only stock for sale is 1,000 shares, which went to the parent company for the license. For this $50 is said to be asked. The stock of the Minneapolis Company is reported 90 asked.

W. I. B.

WESTERN NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
44 Lakeside Building, Chicago, March 23, 1889.

The Standard Electrical Works, Cincinnati, O., report business good, spring building bringing them large orders for supplies. They are equipping two large electric street railway plants with bare and insulated wires.

Mr. J. H. Shay, of the Munson Belting Company, has sold to the Sioux City Cable Road Company 110 feet of 40 inch double belting, and has also belted up the plant of the Council Bluffs, Ia., Electric Light and Power Company.

Overhead Wire Agitation in the Far West.—The citizens of Omaha are working up quite an indignation about the overhead wires in their city. There was a big protest recently against the granting of any rights to any company using the overhead system for electric roads. In spite of this the mayor of the city signed the ordinance and the companies can now go ahead as fast as they desire. A dispatch from Omaha says that the Mercer Motor Company has a big force at work setting poles, and it is understood that the company will proceed as soon as the necessary arrangements can be made to build a line to South Omaha.

A New Chicago Firm.—Lodge, Davis & Co., of Cincinnati, now have their Chicago store fully equipped, are well pleased and are now thoroughly organized for business. The factory has been obliged to increase its force of men largely since Jan. 1 to keep up with the press of business. During the month of February they made shipments of a number of carload lots, also two shipments of their lathes to Stockholm, Sweden. They will shortly put on the market an improved planer which will have some new and novel features, being fully up to the times in weight, solidity and new

ideas. This is to be followed shortly by an improved milling machine. The firm are certainly very enterprising and are making great progress.

Business of the Excelsior Electric Company.—The electric light bids for the Capitol Building at Madison, Wis., made by the Thomson-Houston, Excelsior and Brush Companies, have been referred to a special committee, consisting of the Secretary of State, Attorney General and Governor, to determine which bid was the most acceptable for the purpose of lighting the Capitol and surrounding grounds. The Excelsior Electric Company have been awarded the contract for the Merchants Electric Light & Power Company, of 31st Street, Chicago, for sixty arc lights. L. P. Kadish, of the Vienna Bakery, has awarded the contract to the Excelsior Electric Company for a 100 light incandescent plant for lighting the Chicago City Garbage factory. Allen C. Tanner, proprietor of the Mt. Vernon, Ill., Electric Light Company, has increased his plant with fifteen Excelsior lights. The Excelsior plant of sixty arc lghts at South Evanston, Ill., started up last Saturday night to the entire satisfaction of the inhabitants of that beautiful village.

W. A. N.

MILWAUKEE, WIS., March 16, 1889.

Underground Wires.—The underground wire system, which was inaugurated this summer in connection with the fire and police alarm telegraph will be extended so as to include districts not now provided with the system. About $20,000 will be expended in this work. At present 5,800 feet of conduits are underground, and with the expense of laying the cables the system has thus far cost $5,348.

A New Electric Lock.—Dr. Clark, Superintendent of the County Insane Asylum, has invented a patent electric lock. He gave an exhibition of its workings yesterday, and by simply touching a button in his office he threw open ten doors in the asylum. He claims it would be a great safeguard in case of fire.

Electric Light at La Crosse, Wis.—An important transaction has just been consummated in the sale to a company of "unknowns," said to be partly from out-of-town, of the Gas Light and Brush Electric Light properties, valued at nearly a quarter of a million dollars. It is said that the Edison Electric Company's stockholders are behind the deal.

THE TELEGRAPH.

New York Bucket Shops.—A bill has been introduced in the New York Assembly to abolish bucket shops.

Springfield, Mo., is in want of an electric fire alarm system. Mr. G. B. Brownson is chairman of the Fire and Water Committee.

The Western Union Company has declared a quarterly dividend of 1¼ per cent and a surplus of nearly three-quarters of a million is carried over.

Halifax to Bermuda.—In the House of Commons on March 21, Postmaster-General Raikes announced that the Government intended to lay a submarine cable between Bermuda and Halifax.

The Champlain Telegraph Company has been incorporated to connect New York City, Plattsburg and Loon Lake. The line is to be constructed through the Adirondacks from Plattsburg to Loon Lake. The capital is $10,000. The incorporators include Senator Henry Russell and Charles E. Arnold.

Cable Addresses.—On and after May 1 next, all cable addresses registered by the Atlantic Cable companies for places in Europe other than in Great Britain and Ireland will be canceled. It will, therefore, be necessary for persons cabling to acquaint themselves with the local telegraphic addresses of their correspondents, and to use them. The companies will retain on their books for delivery of messages in America such words at present registered as may be desired.

A Rival to Western Union.—The South Atlantic Telegraph Company, of Baltimore, Md., has been incorporated with a capital stock of $50,000. It is said that the new company is to form a link in the Mackay-Bennett and Postal Telegraph Cable Company system, and is for the purpose of purchasing and owning the lines of that system in Maryland, which are now only leased. The scheme embraces an amalgamation with the Southern Telegraph Company, of Virginia; the Southern Telegraph Company, of North Carolina, and the Southern Atlantic Telegraph Company, whereby lines of wire may be secured extending to New Orleans and covering the entire south and southwest. This entire system is to be controlled by the Mackay-Bennett management.

THE TELEPHONE.

Putting in Multiple Boards.—The telephone exchanges at Newport and Woonsocket, R. I., have just arranged to equip with multiple switchboards of a capacity of 1,000 wires.

Augusta to Atlanta.—Manager Gentry, of Atlanta, and Manager Murphy in Augusta and their friends have recently been talking over the wires between the two cities—171 miles apart—with excellent results.

Telephone Legislation.—Considerable surprise is shown because the New York Assembly Committee on General Laws has compromised the two telephone bills and so altered the bill agreed upon that its operation should be restricted solely to the city of New York. The rate of telephones was made $100 a year for that city. It is probable that this action foreshadows no action at all on any general bill applying to the whole State.

Bell Telephone Dividends.—The directors of the American Bell Telephone Company, at a meeting on March 16, declared the regular dividend of $3 per share, payable April 15. The company's books will be closed from April 1 to April 13. They will also be closed for the annual meeting on the 26th inst., from March 21 to March 26. No action on the election of a successor to President Stockton was taken, and none probably will be until after the annual meeting.

THE ELECTRIC LIGHT.

Lawrenceville, Pa., will adopt the electric light.

Athens, Tenn., is talking about electric light again.

Richmond, Ky., is to have an electric light company.

Joplin, Mo.—The electric light plant has been destroyed by fire.

Dayton, Wash. Ter., has put up $10,000 for an electric light lant.

Wapak, O., will probably have a plant put in of the Silvey system.

Harrodsburg, Ky.—The city proposes to adopt arc lamps for street lighting.

Nashville, Tenn.—The Brush Company have begun work on their new station.

Portage City, Wis., is adopting the electric light. Mr. J. C. Britt is city clerk.

New Decatur, Ala.—The City Council is likely to invest in an electric light plant.

Irvine, Ky.—Estimates on a small plant are wanted by the Estill Springs Company.

Decatur, Ala.—The Decatur Electric Light Company will, it is reported, enlarge its plant.

Henderson, Ky.—An electric light plant is to be put in by the Marshall Milling Company.

Frankenstein, N. H.—An electric light plant is being put in the mill of J. F. Smith & Co.

Wheeling, W. Va.—The Reyman Brewing Company will put in an Edison plant of 225 lights.

Rome, Ga.—The Rome Gas Light Company has received a lighting contract from the city.

London, Ont., has awarded electric lighting contracts to the Ball Company and to Hunt Bros.

Newport, Ark.—Mr. L. Hirsch, of Newport, is in the market for a 500 light incandescent plant.

Delphos, O.—The new Delphos Electric Light and Power Company has a capital stock of $10,000.

Vincennes, Ind.—The Vincennes Electric Light Company will probably more than double its plant.

McIntosh, Seymour & Co. have placed a new engine in the Woburn, Mass., electric light station.

Richfield Springs, N. Y., has voted to adopt the electric light and will probably start off with 22 arcs.

Muscatine, Ia., is to adopt some incandescents for street lighting. Mr. D. T. Eaton is the city clerk.

Train Lighting.—A bill has been introduced at Albany to light by electricity all railway cars in this State.

Windsor Locks, Conn.—The Windsor Locks Electric Lighting Company, is receiving proposals for a plant.

Ogden, Utah.—The new depot at Ogden is to be lit by an Edison plant of a capacity of 350 lamps of 16 c. p.

Leeds, Mass.—Mr. G. P. Warner proposes to utilize the Cook Dam water power for a Thomson-Houston plant.

The Sun Electric Company has, it is stated, passed into the hands of the Thomson-Houston Electric Company.

Cincinnati, O.—Judge Goebel has sanctioned the use of the streets for circuits by the Hauss Electric Company.

Bridgeton, N. J.—The Bridgeton Electric Light Company proposed to put in an incandescent plant of 1,200 lights.

Minersville, Pa.—The Minersville Electric Light Company is to furnish the place with 20 arcs at $125 per annum per lamp.

Marietta, Ga.—A contract for electric light plant has been awarded to the Indianapolis Jenney Electric Light Company.

Lambertville, N. J.—The council has given an electric light franchise to the Electric Construction Company of New York.

Slatington, Pa.—The Citizens' Electric Light, Heating and Power Company has been formed with a capital stock of $20,000.

Delphos, O.—Mr. A. Shenk is president and Mr. S. D. Chambers secretary of the Delphos Electric Light Company recently formed.

Stroudsburg, Pa.—The Stroudsburg Electric Light and Power Company has been incorporated with a capital stock of $15,000.

The Metropolitan Museum of Art in Central Park, New York, is receiving an Edison installation, which will soon be running.

Sedalia, Mo.—The city council will re-let the electric lighting contract, the Sedalia Electric Lighting Company having thrown it up.

Brewer, S. C.—The Brewer Mining Company contemplate putting in an 80-stamp gold mill this summer, and will require electric lights.

Duquoin, Ill.—Mr. G. F. Blakeslee is to decide on a plant for general lighting, probably incandescent, within the next four or six weeks.

Paris, Ky.—An electric light company is being formed by G. Varden, J. Webb and others. A plant will be put in during the summer.

Morganfield, Ky.—G. H. Hughes, Jr., and others, propose starting a small electric light plant, and would like some figures as to cost, etc.

Will Township, O.—The United Electric Light and Power Company, of Will Township, has been formed with a capital stock of $16,000.

Thomasville, Ga.—An electric light franchise has been granted to J. W. Reid and others. A Thomson-Houston plant will be put in.

Americus, Ga.—A proposition for street lighting has been made to the city council by the New York Contract Company, of New York city.

Houghton, Mich.—Mr. J. R. Dee has contracted to wire the new directors' building of the Calumet & Hecla Company for bells and lamps.

Fayetteville, Ark.—A small plant is to be put in by the Fayetteville Milling Company. About 25 incandescents with engine are wanted.

Adams, Mass.—The L. L. Brown Paper Company, of Adams, Mass., are to put an electric light plant in their big paper mills at Adams, Mass.

Florence, Ala.—The Florence Electric Light and Power Company is reported by Mr. E. B. Comly to have its Waterhouse plant in operation.

Sault Ste. Marie, Ont.—The Sault Ste. Marie Water, Light & Power Company has put in a large Heisler plant for street and commercial lighting.

Pulaski, Tenn.—President J. S. Wilkes of the Martin Female College, intends spending $15,000 to $20,000 in improvements, including electric plant.

Searcy, Ark.—The Searcy Electric Light Company has been organized by M. G. Pettey and others. It wants a complete plant of 700 incandescents.

Egg Harbor City, N. J.—Mr. G. W. Tilsby, agent, has closed a contract for an Edison central station of 600 16 c. p. lamp capacity for Egg Harbor City.

Concord, N. C.—The Concord Electric Light Company has elected Mr. J. M. Odell as president, and Mr. J. W. Cannon as secretary and treasurer.

Chester, S. C.—The Chester Electric Light and Power Company has been incorporated by G. J. Patterson, J. J. McLure, W. M. Nicholson and others, with a capital stock of $5000 and will put in its plant at once.

Aberdeen, W. T.—The Aberdeen Electric Light Company has been formed by J. G. Weatherwax, G. Dallen and others, with a capital stock of $10,000.

South Carroll, Neb.—The new Edison electric light plant at South Carroll (Neb.) is now very near completion. It will be in operation in about a week.

The Baton Rouge (La.) Electric Light Company has contracted for all necessary machinery, poles, wire and other material required for its plant.

Belleville, Ill.—The Citizens' Electric Company, of Belleville, has been formed with a capital stock of $100,000 by S. W. Baird, S. P. Baird and J. J. McDowell.

Santa Barbara, Cal.—The Santa Barbara Electric Light Company has a new 150 h. p. engine, of the Corliss type, built by the San Francisco Tool Company.

Troy, N. Y.—The Troy Electric Light Company has the contract for lighting at 43¾ cents per lamp per night, as before. Not less than 271 lamps are required.

Evanston, Ill.—The Evanston Electric Light and Power Company has been formed by J. S. Philip, J. D. Adams and J. K. Johnston, with a capital stock of $30,000.

Marietta, O., has received a number of bids on its proposed plant. The bids on plant complete for 55 lamps, including boiler and engine, range from $10,725 to $12,230.

Beardstown, Ill.—The Beardstown Electric Light and Power Company has been formed by H. Ehrhardt, G. Bley and W. E. McCullough with a capital stock of $20,000.

Jonesboro, Ark.—Mr. J. B. Dillon and others are incorporating their electric lignt company and will have put in their plant of about 600 incandescents in four months.

Hagerstown, Md.—The Hagerstown Electric Company, recently formed by C. E. S. McKee, T. B. Cushwa, J. Rosner, and others, proposes to buy the Schuyler plant.

The Perkins Electric Lamp Company has been formed at Manchester, Conn., to operate in conjunction with the Mather Company and to manufacture for the market.

Langhorne, Pa., is putting in a Thomson-Houston incandescent plant for street lighting. The Langhorne Electric Light and Power Company has a capital stock of $20,000.

Roanoke, Va.—The officers of the new Roanoke Electric Light and Power Company are: S. Griffin, president; W. H. Stoll, secretary and treasurer. The capital stock is $25,000.

Marseilles, Ill.—The Illinois Valley Electric Light and Power Company will locate its plant at Marseilles and run circuits to Ottawa and Seneca. Water power will be used.

Hickory, N. C.—The Hickory Electric Company has been formed by A. A. Shuford, D. W. Shuler, J. A. Martin and H. D. Abernethy, to operate the Brush plant in that place.

Maywood, Ill.—The Maywood and Proviso Electric Light and Power Company has been formed by J. Jennings, C. W. Kimball, H. P. Nichols and others, with a capital stock of $20,000.

Lewiston, Ill.—The Lewiston Electric Light, Heat and Power Company has been formed by L. W. Rose, D. D. Talbot, J. M. Stewart and P. J. Stoddard, with a capital stock of $10,000.

Berlin Falls, N. H.—Mr. J. H. Cary, of Woonsocket, has put in a compensating plant of the alternating system at Berlin Falls. There is also a Waterhouse arc plant. Water power is used.

Chappaqua, N. Y.—The Chappaqua Mountain Institute, a school for boys, is to be lighted with electricity, the trustees having purchased a plant of the Edison system of 162 lights for $2,100.

Oneonta, N. Y.—The Electric Construction Company, Limited, of Oneonta, N. Y., has been formed with a capital stock of $5,000 by F. Gould, F. D. Miller, H. E. Bundy, G. T. Bugden and C. Briggs.

The Detroit Storage Battery is being used on the lake steamer "City of Cleveland," in connection with electrical signaling apparatus. The plant was put in by Parrish Bros. & Peck, of Detroit.

Hanover, N. H.—An electric light company is being formed to put in a plant at Olcott Falls from which to supply White River Junction, Hartford and Norwich, Vt.; Hanover and the two Lebanons.

The Interior Electrical Conduit Company has been incorporated in this State by E. H. Johnson, E. T. Greenfield, W. J. Jenks, L. Stieringer, J. H. Vail and others with a capital stock of $150,000.

Turtle Creek Valley, Pa.—The Turtle Creek Valley Electric Light Company has been formed by A. Marthens, F. Wilcox, E. E. Little and others, to light several townships in that section of the country.

Danvers, Mass.—The Danvers Gaslight Company has petitioned the Legislature for the right to furnish electric light to the inhabitants of Danvers, and a hearing will be had in the town hall, Danvers, April 11.

Mauch Chunk, Pa.—The Mauch Chunk Electric Light Company has organized with the following officers; E. B. Leisenring, president; C. A. Rex, vice-president; F. Bertolette, secretary; R. Ruddle, treasurer.

Woonsocket, R. I.—The Union Electric Light Company has been formed with a capital stock of $20,000. A. H. Morse is president and C. E. Griffin, secretary. The directors include H. W. Burgett and M. W. Turner.

Newbern, N. C.—The plant recently installed by the Schuyler Electric Company for the Fair Association, as an exhibition plant, was such an unqualified success, that the Association have purchased the entire outfit.

Concord, N. C.—Mr. J. M. Odell is president of the Concord Electric Light Company, and Mr. J. W. Cannon secretary and treasurer. The company is to light the streets, stores and residences with the Edison system.

Lehighton, Pa.—The Lehighton Steam Heating and Light Company has been formed by E. B. Leisenring, G. Ruddle, J. Sondheim, C. A. Rex and others, with a capital stock of $40,000. Work will begin in the spring.

Patchogue, N. Y.—The Patchogue Electric Light Company has declared an annual dividend of 4 per cent. Patchogue is one of the popular summer resorts of Long Island, and it is now proposed to run an electric road there.

Wichita, Kan.—The Citizens' Electric Light Company, operating a Schuyler plant of about 250 arcs, is going in for an incandescent service, and will put in two 650 light alternating machines, wiring up at first for 1,800 lamps.

Cedartown, Ga.—The Empire Water, Light and Manufacturing Company, of Cedartown, has been organized by C. P. Ball and others with a capital stock of $100,000. It intends to build an electric light plant, among other things.

Kansas City, Kan.—Mr. Pantaleoni, representing the Westinghouse Company, has closed a contract with the Kansas City (Kan.) Electric Light & Power Company for an incandescent plant to be added to the present arc plant.

Nyack, N. Y.—A resolution to make a five years' contract with the present electric light company was voted down at the village election in Nyack, but at Upper Nyack and South Nyack the people voted heartily in favor of electricity.

Paterson, N. J.—The Edison Company, of Paterson, N. J., has placed incandescent lights in the house of Engine No. 3. They are made to light up when the alarm is sounded. The same contrivance causes the doors to swing open.

Wilmington, N. C.—The North Carolina Power Company succeeds the Wilmington Electric Light Company. Mr. H. A. Burr is president, W. L. Smith secretary and E. P. Bailey manager. More Thomson-Houston apparatus will be bought.

Wachusett, Conn.—A large portion of the stock of the Wachusett Electric Light Company has changed hands, and T. K. Ware has been elected president, and H. F. Cogshall treasurer and manager. It is proposed to build a new station.

California Dividends.—A San Francisco paper in a statement of dividends for 1888 places the California Electric Light Company at 12 per cent., or a sum of $120,000, and the San Diego Gas and Electric Light Company at 9 per cent., or $11,250.

Lighting Steamships.—All the steamers plying between Philadelphia, Baltimore and Liverpool, belonging to the Atlantic Transport Company, are being fitted for electric lighting, a 150-light Edison dynamo being placed aboard of each vessel.

Whitman, Mass.—The Whitman Electric Light Company has organized with D. A. Gurney as president, A. Davis as treasurer and C. D. Nash as secretary. The capital stock is $20,000. The contract with the local authorities is for five years, at $3,000 per year.

A Light of 7,000,000 c. p.—Capt. Sydney Webb, deputy-master of the English Trinity House, says that the illuminating power of the improved electric light at St. Catherines Point, Isle of Wight, is rather more than 7,000,000 candles. De Meritens magneto-electric machines are used.

San Rafael, Cal.—The San Rafael station, Mr. B. C. Roos writes us, contains two No. 7 Brush dynamos—30-lighters. They supply 24 lights to the city on 60-feet masts, and a search light at San Quintin, four miles away. They also furnish 11 lights to the San Quintin State Prison.

Troy, N. Y.—Mr. A. E. Powers, president of the Troy (N. Y.) Electric Light Company, has purchased a controlling interest in the local Edison Electric Light Company. Mr. Powers has been elected president of the new company; Joseph A. Powers, treasurer, and F. A. Harrington, secretary.

Bloomington, Ill.—The new officers of the Bloomington Electric Light company are: R. W. Murphy, president; L. M. Graham, vice-president; C. Rayburn, secretary and treasurer; J. H. Miller, superintendent. Among the directors are R. T. McDonald, C. L. Olds and W. J. Buckley.

Fall River, Mass.—The Fall River Electric Light Company have elected the following officers: President, M. J. Perry, of Providence; clerk and treasurer, F. O. Dodge. Directors: M. J. Perry, F. S. Stevens, J. D. Flint, W. H. Hathaway, F. O. Dodge, E. L. Anthony and W. B. Hosmer, of Boston.

The Schuyler Electric Company, of Middletown, Conn., report several new contracts for central arc lighting stations. Their working force has recently been very materially increased. They have also added several improved tools to their plant in order to accommodate their increasing business.

Mankato, Minn.—The Mankato Gas and Electric Light Company has bought the gas works and electric light plant, and will operate both. John F. Meagher is president of the new company; F. L. Waters, vice-president and manager; R. E. Brown, secretary, and George M. Palmer, treasurer. The capital stock is $200,000.

Winchester, Va.—The Winchester Gas Light Company have been in the field some time for an arc light plant, and, after a very exhaustive investigation, have ordered their apparatus from the Schuyler Electric Company. They expect to have the plant running by May 1. The steam plant will be furnished by the Taylor Manufacturing Company.

St. Charles, Mo.—The special committe of the St. Charles' city counsel has deferred, until after the Spring election, final action on the application of the St. Charles Gas Light and Coal Company for an electric lighting franchise. The matter will be settled therefore when the new board meets. Mr. F. Marten is president of the company; Mr. T. Bruere secretary, and Mr. M. Devine, superintendent.

Electric Lighting in the South.—A number of contracts have been closed recently in the South for electric lighting plants Cedartown (Ga.) has just closed one and Jackson (Miss.) was lighted last week for the first time. The plant was of the Fort Wayne Jenney system.

The Union Pacific Railway Company has awarded a contract to R. M. Jones, of Laramie, Wyoming, for the supply and thorough equipment of a 350-light Edison station for lighting the Union depot and passenger yards at Ogden, Utah. This contract includes the supply of the power station also, which will consist of a 35 h. p. Ide engine. Latest improved Edison appliances and machines will be used.

Staunton, Va.—Mr. J. Hotchkiss has obtained a concession for lighting and expects to organize a company soon. He is now investigating the subject. Mr. Hotchkiss is president of the Grottoes of the Shenandoah Company, which has just completed a very fine and extensive incandescent plant of the Westinghouse system in its Weyer Cave and the hotel at the Grottoes station of the Shenandoah Valley railroad.

A New York "Deal."—The control of the local United States Electric Illuminating Company has passed into the hands of the Westinghouse Company, which will at once improve the old plant, enlarge the scope of operations, and establish an *entente cordiale* with the Board of Electrical Control. It is said that the Westinghouse Company will not have occasion now to build the proposed large station at the foot of West 24th street.

Texarkana, Ark.—The Texarkana Gas and Electric Light Company have purchased the Gas Light Company and the electric light plant of the Texarkana Ice Company. They have consolidated the plant and are now in the market for gas engines to run their dynamos. They are also desirous to learn something as to the cost of running the local street railway with direct supply of current or with storage batteries. Mr. E. N. Maxwell is president of the road, Mr. N. W. Bechtel, manager, and Mr. T. E. Walters, secretary.

Bowling Green, O.—The City Council of Bowling Green have awarded the contract for lighting their city to the Silvey Electric Company, of Lima, O. Three other companies were bidding for the work. The Bowling Green Council made a trip to Ada and gave the Silvey plant in that city a thorough inspection before awarding the contract. The plant will consist of 50 arc lights and a 600 incandescent light dynamo and the contract amounts to over $25,000.

Providence, R. I.—A special dispatch from Providence of March 11, says: Negotiations for the consolidation of the electric lighting interests of this city are practically concluded. The Narragansett company will absorb the Rhode Island company, issuing stock in payment for the plant of the smaller concern. The Narragansett company is now building a large station. It uses Thomson-Houston arc lights and the Westinghouse alternating system for incandescent service.

Salem, N. J.—A neat plant has been installed at Salem, N. J., by Mr. A. H. Rennie, of 171 Broadway, this city. It consists of two Westinghouse dynamos of 1,200 lights capacity and one 40 light Waterhouse arc machine, supplying 32 lights to the city and the others to commercial customers. The work was done under the supervision of Mr. John S. Marshall, who lately installed the Lacodia, N. H., plant for Mr. Rennie. Mr. Rennie expects to complete the Salem plant by April 1, and then to take up several new installations now awaiting his attention.

Springfield, Ill.—A. L. Ide & Son have received a ten-year contract for lighting the streets of Springfield, Ill., with arc lights of 2,000 candle-power at $137 per year for each light. In connection with this contract they have agreed to furnish incandescent lights for commercial use at a price not to exceed the cost of gas of equal illuminating power at $1.50 per thousand feet. They will also furnish current for electric motors from ¼ to 10 horse-power within 2,000 feet of their station at a cost not to exceed $100 per year for each horse power for ten hours' use per day. They will erect a new station of sufficient size to enable them to operate the street railways, of which Mr. Ide is president, by electricity.

Lafayette, Ind.—A dispatch of March 7, from Lafayette, says: Considerable surprise was caused here on Tuesday upon the announcement that a receiver had been appointed for the Lafayette Brush Electric Light Company. The Brush Company, of Cleveland, held $26,000 in bonds of the Lafayette Company, upon which the interest defaulted January 1, 1889. These bonds are secured by a mortgage upon the property of the local company. The complaint of the Brush Company, of Cleveland, also alleges that the Lafayette Company is indebted in the sum of $25,000 to divers persons. The local company now has the contract for street lighting in this city, and it is to protect this contract, which has a year yet to run, that John W. Heath, of this city, was appointed receiver.

Mount Holly, N. J.—The plant of the Mount Holly Electric Light Company is declared a great success. The Edison system is used. The plant includes capacity for about 800 lights of 16 c. p., and over 400 have already been contracted for. The Edison municipal system is used for the streets to the extent of 150 lights. The motive power is furnished by Armington & Sims engines of 80 and 30 horse-power respectively. They were put in by the H. B. Smith Machine Company. The boiler is over 100 horse-power. The officers are: President, Amos Gibbs; treasurer and secretary, Howard C. Levis; superintendent, Clayton H. Page. The poles and wires were put up by the Edison Company, and J. L. Jamison had charge of the house wiring. The total cost of the plant is $14,000. The amount of stock issued is $12,000, and the company has option of issuing $3,000 additional if deemed advisable.

Council Bluffs, Iowa.—The Union Pacific has concluded to put in an electric light plant at the union depot in Council Bluffs to dispel the darkness there and about the platforms. At present the company uses gas, the quality of which is said to be inferior. This has been demonstrated during the winter time and in damp weather. It is stated that the company has tired of pressing oil lamps into the service to make up for the gas. A boiler and dynamo, together with the necessary machinery, will be put in at once. The circuit will contain eight 2,000-candle power lights, and will be so constructed that a larger circuit may be operated. For the present the service will be confined to Council Bluffs. It is stated that it is the intention of the company to furnish its own electric light for the depot in Omaha, and the shops at that place. It is thought that the new plant will be in operation in about thirty days.

APPLICATIONS OF POWER.

Americus, Ga.—The Americus Street Railway Company will probably build an electric road.

Decatur, Ala.—The Decatur Street Car Company will, it is said, adopt electricity as a motive power.

Waco, Tex.—The Waco Street Railway Company have asked permission to operate by electricity.

Richmond, Va.—The City Railway Company is now changing from horses to electricity as motive power.

Seattle, W. T., will have its electric road, put in by Messrs. Thompson, Griffith & Kilbourne, running this month.

Concord, N. C., is to have an electric road, and right of way has been granted to a company formed for the purpose.

Charleston, S. C.—The Charleston Street Car Company will adopt electricity. Mr. J. S. Riggs is president of the company.

Nahant, Mass.—The selectmen of Nahant have decided against allowing street railways, electric or other, within the town.

St. Joseph, Mo.—The South Park Railway Company, capital stock $100,000, Directors J. Donovan, J. Hansom, B. Fraser and others, will build an electric road.

Wichita, Kan.—Mr George M. Dickson, superintendent of the City Street Railway, looks favorably upon the adoption of storage for his forty odd miles of road.

Edgewater, S. I.—The trustees of the village of Edgewater, S. I., will sell at auction on April 8 the franchise for an electric motor railroad from Arrochar along South Beach to New Dorp.

The Northwest Electric Power Company has been formed at Tacoma, W. T., with a capital stock of $250,000, by R. F. Radelbaugh, I. W. Anderson, T. B. Wallace and H. C. Wallace.

Utilizing Niagara.—A bill has been introduced in the New York Legislature authorizing the Niagara Hydraulic Electric Company to erect a plant at the Falls, on the Hamilton plan recently illustrated in our columns.

Alliance, O.—The Alliance electric street railway, connecting Mt. Union College and the Union depot, passing through the central part of the city, was formally opened to the public last week and is in great popular favor.

Schome, W. T.—The Bellingham Bay Street Railway Company has been formed by D. R. Huntoon, P. D. McKellar, J. Gise and others, with a capital stock of $25,000, to build street railways, electric light plants, telegraph and telephone lines, etc.

The Atlanta Electric Railway.—Tracks are now being laid in the city of Atlanta (Ga.) and the Thomson-Houston system of street railway cars has been contracted for. The line will be two miles long, and will be double-tracked for the entire distance.

Richmond, Ind.—The committee of the city council has reported favorably on Mr. Shaffer's plan for converting his horse railway into an electric road. It is proposed to use the Thomson-Houston overhead conductor system and to have the road running by July 15.

Winston, N. C.—The Winston Electric Light and Motive Power Company owns the exclusive franchises for electric and gas lighting and for street railways in that place, a town of about 11,000 inhabitants. The plant and franchises of the company are for sale. Mr. W. A. Whitaker is the president of the company, and Mr. S. E. Allen is secretary and treasurer.

Cincinnati, O.—Work has just begun on the Coleraine avenue line of the Cincinnati Street Railway Company for an electrical equipment of eight Thomson-Houston cars. Mr. E. P. Morris, who has charge of the work, expects the road to be running about May 15. He will put up three miles of double track, with double overhead wires, avoiding the use of the rail as return.

St. Joseph, Mo.—The People's Street Railway and Electric Light and Power Company, of St. Joseph, has been formed with a capital stock of $800,000, in shares of $100. The stock is owned as follows: James B. Newcombe, New York, 2,000 shares; Oliver Harriman, Jr., New York, 2,000 shares; Stephen S. Palmer, New York, 1,000 shares; Camille Weidenfeld, West Orange, N. J., 1,500 shares; Arthur J. Moulton, New York, 1,000 shares; Lathrop R. Bacon, New York, 497 shares, and Joseph A. Corby, Charles A. Shoup and Thomas F. Van Natta, of St. Joseph, one share each. The board of directors comprises all the stockholders.

An Electric Yacht.—An electric yacht is soon to be added to the New Haven Yacht Club. It will be owned by one of the wealthiest members. Electrician H. B. Cox has completed the design, and work will be commenced. It is to be 35 feet in length. The accumulators or storage batteries will be placed along the keel of the craft and will number 25 in all. To prevent the strong acids used in the battery from eating the wood work, the bottom of the yacht will be lined with lead. This, together with the batteries, will take the place of ballast. A six h. p. motor will be placed in the stern and connected directly with the propeller. Electrical power will not, however, be used when there is good wind.—*Boston Jour. Com.*

Denver, Colo.—Mr. Frank F. Downes, of Chicago, representing the Sprague Electric Railway & Motor Co., is seeking to form a company at Denver, Colo., to purchase a site near the centre of the manufacturing district of the city and construct a five or six-story building, 50 by 125 feet. It is proposed to place in the basement of this structure a steam power of about 700 h. p., an electric power and light dynamo plant, and to fill the rest of the building with manufacturing industries, the machinery of which would be driven by electric motors. It is planned, in addition, to supply power to any manufactory within a radius of 1½ miles, and to furnish electric light for incandescent systems. The cost of the building and plant would reach $250,000.

Chicago, Ill.—The Jefferson Electric Rapid Transit and Lighting Co. has been formed with a capital of $250,000. The object of the company is to run an electric main from Western Ave. northwest on Elston avenue to Jefferson Park, with branches to tap Avondale, Irving Park, the county buildings and Montrose. One main branch will begin at the 200-acre sub-division that a syndicate have in hand west of and adjoining Jefferson Park, and extend east to Bowmanville. Another will begin at the intersection of Western and Elston Aves., and reach out for patronage from Cragin and vicinity. An ordinance has been applied for for this portion of the road and accompanying lighting plants to the Jefferson trustees, and a favorable decision is expected.

The Detroit Storage Battery.—Mr. Frank E. Snow, the president of the Highland Park Railroad Company, Detroit, has addressed the following letter to the Woodward Electrical Company of that city: "The car "Ampère," belonging to this company, is equipped with 84 cells of your battery, 15 M. S. Type, and a Ra[illegible] motor manufactured by the Detroit Electrical Works. Yesterday the car ran 14 round trips, carrying 486 passengers. The running time averaged 12 miles per hour, and the length of the road is 3 5/8 miles. This would make the distance run over 100 miles. The battery was in good shape when taken off at night, and, in addition to running the car, had been furnishing 2 16 c. p. lights for 5¼ hours. The car could be started with full load on level track or grade without the slightest difficulty."

PERSONALS.

Mr. L. I. Fletcher, of the Nashua (N. H.) Electric Light Company, has become superintendent of the Lowell Electric Light Company.

Col. C. W. Jenks, the manager of the mining and milling department of the Sprague Company, has just returned home from an important Western trip.

Mr. Louis J. Hirl, M. E., of the Hill Clutch Works, Cleveland, O., has been spending a few days in Boston on business connected with his company's manufactures.

Mr. A. P. Wright, the electrical engineer, has been called from Boston to New York this week on important business. His services as engineer and consulting expert are in great demand.

Mr. Charles E. Mitchell, of Hartford, Conn., well known in the patent business, has been chosen by President Harrison as Commissioner of Patents, and the selection gives general satisfaction.

Prof. E. P. Roberts, of Cornell, has been in New York and its vicinity in charge of a large party of the electrical engineering students of the university, visiting all the electrical points of interest.

Mr. Willard L. Strong, who has long been prominently identified with local Brush interests in New York city, has resigned as president of the company, and has been succeeded by Mr. W. T. Moore.

Dr. A. V. Garratt has been engaged at Dickinson College, Carlisle, Pa., advising as to the changes necessary to equip an electrical engineering department from whose plant the college is to be lighted.

Mr. J. R. Borden, of Asbury Park, one of the drivers of the Daft electric road, enters himself in the directory as a "motorneer." Shall this word be admitted to usage? It was first brought to notice in our columns some years ago by Mr. G. W. Mansfield.

Mr. Geo. W. Mansfield, of the railroad department of the Thomson-Houston Company, was in New York last week, and reports the company to be pushed to the very extreme of its capacity by the enormous demand for electric railroad equipment.

Judge Willard Bartlett read a paper last week before the Society of Medical Jurisprudence and State Medicine, in which he expressed grave doubts as to the practicability of the law providing for the execution of the death sentence on criminals by electricity.

Superintendent W. M. Brock, of the Lawrence, Mass., Edison Illuminating Company, will sever his connection with the company to accept a position as manager of the new station at Paterson, N. J. His salary is understood to be $2,500, and he leaves Lawence April 1.

Mr. Frank J. Sprague delivered an address at Cornell University, on March 1, before the mechanical and electrical engineers, on "Motors and Electric Railways." The address was one of great force and ability, and was heard with the utmost interest and attention by a large audience.

Mr. F. W. Jones, the electrician of the Postal Telegraph Cable Company, delivered a very able lecture recently at the Young Men's Christian Association, Brooklyn, N. Y., on "The Development of Electrical Transmission by Telegraph and Telephone." The lecture was illustrated and elicited hearty applause from a large audience.

Mr. A. H. Bauer, the electrician of the Pullman Palace Car Company, deserves the credit of the recent successful electric light installations on the special Pullman trains, as noted in our columns, and has applied for patents, which, when issued, he will assign to the company. Mr. Bauer is just home from a trip to Mexico.

Mr. John Crawford, of the Pennsylvania Telephone Company, becomes general manager of the Mexican Telephone Company, at the city of Mexico, on April 1. Mr. Crawford is evidently far from tired of life and adventure in telephone service. It will be remembered that for some time he was prominently identified with telephony in Russia.

Mr. Ernst Thurnauer, engineer of the Thomson-Houston International Company, who will have charge of Professor Elihu Thomson's private exhibit at the Paris exhibition, left for Europe last week accompanied by his assistants, Messrs. Parsons and Jensen, of Lynn, Mass. The greater part of the exhibit has already been shipped abroad, and contains, it is said, some remarkable apparatus never before shown.

Mr. B. Rhodes, of Niagara Falls, N. Y., was in New York last week, making preliminary arrangements for the Niagara Falls meeting in August of the National Electric Light Association. Mr. Rhodes is a good organizer, and will undoubtedly give the Association one of its very best conventions. It is thought that a date early in August will be fixed. There is promise already of a very large attendance of ladies with the delegates.

MISCELLANEOUS NOTES.

Brooklyn Wires.—Senator Worth has introduced a bill at Albany allowing the Board of Electrical Control of Brooklyn to permit aerial electrical wires to be strung along the elevated railway structures.

The Woodhouse & Rawson Electric Supply Company have been allotted a first-class award, equal in value to a gold medal, for an exhibit of electrical apparatus at the Melbourne (Australia) Exhibition.

The Pacific Slope.—The *Pacific Lumberman,* of San Francisco, has started an electrical department and is devoting a large portion of its space to the advocacy of things electrical, with great ability and intelligence.

The Burton Electric Company has been formed at Richmond, Va., to make and sell Dr. Burton's electric heater. The president of the company is Mr. W. E. Tanner and the vice president and treasurer is Mr. C. E. Wingo.

The Electric Liquid Controller Company has been incorporated at Richmond, Va., with a capital stock of $50,000. Mr. T. N. Motley, of New York, is the president; Mr. A. Rosenfield, vice-president, and Mr. W. H. Brown, treasurer.

The Riggs Electric Traveling Danger Signal Company, of Minneapolis, Minn., has been formed with a capital stock of $3,000,000. The incorporators are J. W. Riggs, of St. Paul; D. H. Kingsley and J. A. G. Richardson, of Minneapolis.

Electric Sugar.—Mrs. C. A. Mackay, who holds stock in Friend's Electric Sugar Refining Company, is asking for a receivership. She bases her suit on a belief in the reality of an electric sugar refining process, which Friend demonstrated.

Another Welding Exhibition.—The members of the Boston Electric Club were invited to attend an exhibition of electric welding at the station of the Malden Electric Light Company on Wednesday evening, March 13, by General Manager H. A. Royce. Nearly one hundred members responded to the invitation, and they were well repaid for their time and trouble.

Electricity in Pulp-Mill Processes.—"Electricity is to make the most important improvement of the times in pulp-mill processes," said J. B. Newhall, who was in Lewiston, Me., Tuesday, of last week, as representative of manufacturers of pulp and paper-mill machinery. "It is hard to estimate just what it will do, but this much is quite certain, that it re-invigorates the bleaching liquors and seems to give new and important powers to them. For instance, the liquors are easily vibrated, and soon become inert. Charged with electricity they seem to be fairly alive and to possess new powers which have not been fully appreciated as yet."—*Boston Jour. Com.*

BUSINESS NOTICES.

The Aetna Machine Company, Warren, O., have received an order for the Eureka Iron and Steel Company, Wyandotte, Mich, for a large smith's furnace, gas producer and valves.

Patterson, Jordan & Gottfried, 146-150 Centre street, carry a complete stock of brass and iron machine and wood screws, cap and set screws, all kinds of bolts, taps, files, twist drills, brass and rubber tubing, brush copper, rod and sheet copper, brass rod, sheet German silver, sheet brass, machinery, tools, hardware, etc. Electric motor supplies.

The D. M. Steward Manufacturing Company, of Chattanooga, Tenn., have issued a very neat and effective illustrated catalogue and price-list of their specialties, including their well-known lava electric insulators, which have stood such remarkable tests in practical work, at the hands of various companies. The insulators are fire-proof and water-proof, do not warp and are extremely hard, resisting all mechanical injury.

A. L. Ide & Son, Springfield, Ill., have received an order from the Union Iron Works, of San Francisco, to deliver within three weeks two Ide engines of 150 h. p. each and one of 100 h. p. They have received orders for ten engines in the last two weeks, all to be delivered within 30 days, which necessitates running their works nights. Their new works are in full operation and are turning out from two to three engines per week.

Learn Shorthand.—There is no better way for an operator to improve his leisure hours and qualify himself to fill a better position than to learn shorthand writing. W. G. Chaffee, of Oswego, N. Y., whose advertisement has appeared in these columns for several years, gives instruction by mail, and has the reputation of running one of the best schools of this kind in the country. Write him for circulars before investing money in any system. Tell him what time you have for study, and he will answer your letter honestly and conscientiously.

A Good Word for Kidder.—

CORTLAND, N. Y., Jan. 16, 1889.

Jerome Kidder Manufacturing Company, 820 Broadway, N. Y.

DEAR SIRS: Will you be so kind as to send me a copy of your new work on Electro-Therapeutics and greatly oblige one who has used a Kidder machine ever since he has been in practice, some twenty-six years, and always has a good word to say for it because it deserves the highest praise. Truly yours,

DR. JAMES W. HUGHES.

OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS.

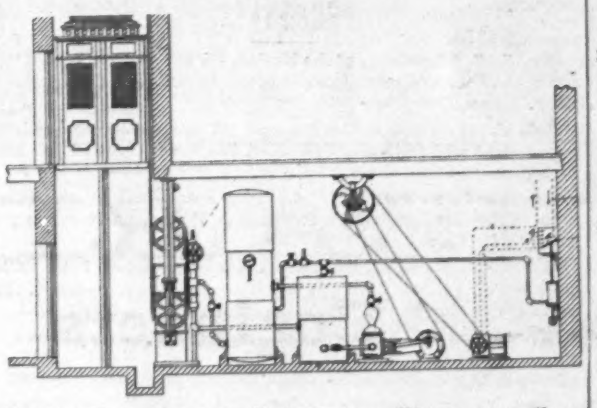
PATENTS DATED MARCH 19, 1889.

399,646. Dynamo-Electric Machine; Joseph W. Balet, of New York, N. A., Assignor of one-half to Robert Dunlap and Luke F. Cozans, of same place. Application filed Feb. 1, 1888. The invention consists in a dynamo-electric machine having an armature core grooved longitudinally with respect to the armature and transversely with respect to the field-magnet, and in the combination therewith of one or more conductors wound in the grooves of the armature.

399,666. Telephone Transmitter; Charles A. Hitchcock, of North East, Pa., Assignor of two-thirds to Samuel A. Davenport and William Burnley, of same place. Application filed Feb. 12, 1887. The object of the invention is to provide a transmitter box or casing that shall be capable of adjustment at different angles relatively to the plane of the horizon, and shall have means for adjusting and holding it at the desired angle. To attain such end the box or casing of the transmitter is hung or pivoted to a support upon which it can be swung, in order to cause a rolling or sliding electrode placed on an inclined stationary platform to bear with more or less pressure against the diaphragm-electrode, and thus obtain the proper adjustment of the electrodes in accordance with the requirements of the case.

399,716. Electrically-Controlled Hydraulic Elevator; Charles Whittier, of Boston, Mass. Application filed Jan. 25, 1887. The invention consists, essentially, of a regulator operated by changes in pressure of the fluid used to actuate the elevator, a pump and an electric motor, combined with a switch controlled by the regulator to affect the circuit of the electric motor to start or stop the pump, according to the pressure of the fluid employed. See illustration.

399,732. Electric-Railway Switch; Edward Blake, of Boston, Mass. Application filed Oct. 22, 1888. A switch of the variety known as a "tongue-switch" is used, in which a movable tongue on one or both of the rails directs the wheels of the car in one or the other direction, according to the position of the tongue. This tongue is rigidly attached to its central pivot, which pivot is extended downward through the base of the switch into a box below. On the lower end of this pivot is attached an arm in a similar manner, and this arm is provided at its free end with a curved metal bar or rod placed transversely to said arm, which may be acted on by one or more electro-magnets, or electric motors, or



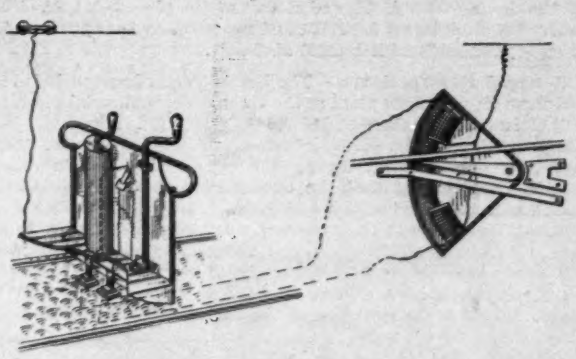
399,716. ELECTRICALLY-CONTROLLED HYDRAULIC ELEVATOR.

solenoids suitably placed so as to move the arm to and fro, and therefore to move in a similar manner the tongue of the switch above. See illustration.

399,738. Coupling and Automatic Circuit-Breaker for Fire-Alarm Circuits; John J. Cannan, of Rochester, N. Y. Application filed Jan. 26, 1889. The invention consists of a combined breaker and coupling formed by clamping the wires between suitable plates, one or both of which are preferably good conductors of electricity, and maintaining the clamping plates in position by means of a fusible retainer or metal, which will melt at a low temperature.

399,748. Incandescent Electric Lamp Socket; Charles E. Egan, of Columbus, Ohio., Assignor of one-tenth to N. W. Halley, of Tipton, Indiana. Application filed July 11, 1888. The invention consists of an incandescent lamp in which the circuit through the filament may be made and broken and the lamp firmly secured in its socket by simply manipulating the body of the lamp, no key being used.

399,755. Electrical Distribution by Secondary Batteries; Frank King, of Fulham, County of Middlesex, England. Application filed Oct. 22, 1888. In carrying out this invention two or more pairs or sets of secondary batteries may be employed, their action of charge and discharge being alternate, except on occasion when both sets of batteries may discharge into the distributing main together. Each set of batteries is attached to a rocking switch whose function is to transfer the connections of the batteries from series to parallel or vice versa, and by the movement of which the batteries are placed in the charging and



399,732. ELECTRIC RAILWAY SWITCH.

discharging circuits, respectively, and the pressure of the gas evolved from one or more of the plates in each battery is utilized for operating the switches and special parts of the apparatus.

399,786. Electric Light Support; Benjamin Schardt and George Jones, of Dayton, Ohio, Assignors of one-third to John R. Fletcher, of same place. Application filed March 19, 1888. The object is to hold an arc lamp in a fixed position while the electric circuit is formed through the connection pieces of the dome, and thereby making the said circuit secure, which could not be the case while suspended by cords, which contract and expand by moisture and are subject to loosening.

399,800. Dynamo-Electric Machine; Elihu Thomson, of New Britain, Conn., Assignor to the Thomson-Houston Electric Company, of Connecticut. Application filed May 25, 1883. The invention relates to dynamo-machines in which there are combined two or more series or sets of bobbins, each set wound upon one or more iron forms or cores and revolving in opposite directions, and each provided with a commutator, the whole operating by the interaction of two sets of bobbins or coils moving oppositely and in inductive relation to one another. See illustration.

399,801. Alternate-Current Inductor; Elihu Thomson and Merle J. Wightman, of Lynn, Mass. Application filed Aug. 8, 1888. The invention consists, essentially, in the combination, with an alternating inductor, of a locally-applied modifier or retarder of the inductive action applied directly or indirectly to a part of the field of inductive action directly or indirectly set up by said inductor, whereby a lagging of the alternations of inductive action produced by such part behind those of an adjoining part or parts will be produced, thus giving the effect of two or more adjoining sets of alternations of induction differing or displaced, more or less, in phase.

399,822. Electric Blast-Blower; Harry H. Blades, of Detroit, Mich. Application filed July 23, 1887. It is the object of the invention, first, to combine directly with a blower an electric motor in such a manner that the wings of the blower shall project from the periphery of the armature of the motor, said armature substituted in place of the ordinary rotary head; second, to provide a suitable casing to inclose the armature and its attached blower-wings, whereby air may be drawn in by the action of the blower and delivered under pressure at any desired point.

399,826. Electric Conductor; Alfred A. Brooks, of Cambridge, Mass. Application filed Sept. 10, 1888. An electric conductor consisting of a wire having an insulating layer or coating, and a single-ply tightly-woven jacket or covering composed of a single set of longitudinal yarns or warps, and two or more wefts interwoven with all the said warps and extending around the conductor in parallel course and passing alternately over and under the said warps.

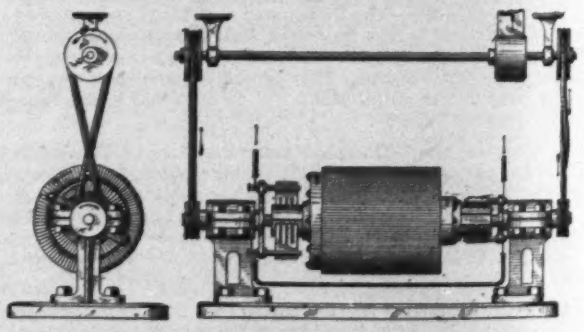
399,950. Friction-Gear for Electric Motors; Charles J. Van Depoele, of Lynn, Mass. Application filed Oct. 31, 1888. An important feature of the invention consists in so arranging the mechanical connections that at desired times the armature-shaft can be freed from all connection with its load by electrically or mechanically operated mechanism and be allowed to rotate freely, so that in case of an electric railway car, when it is desired to bring a vehicle to a stop suddenly or otherwise, according to the invention, the connection between the gearing and the armature of the motor is severed and the car stopped by the application of brakes.

399,954. Hinge-Joint for Electric Belts; Nicholas Warren, of Farragut, Iowa. Application filed Oct. 17, 1888. The invention relates more especially to a brace or stay for strengthening the plates or elements of the cells of an electric belt, and which is also constructed to form a hinge-joint between the several elements or plates of the series of cells.

400,028. Electric Alarm Signals for Cables; William H. Woodring and Clarence S. Gilbert, of Kansas City, Mo. Application filed July 2, 1888. The object is to provide simple and effective means, whereby the breaking of one or more of the strands of a cable employed to propel cars and the like, as in cable railways, mine cables, etc., may be detected before the cable has become sufficiently weakened to break entirely in two.

PATENTS EXPIRED MARCH 19, 1889.

124,773. Improvement in Apparatus for Lighting and Extinguishing Gas by Electricity; John Vansant, of San Francisco, Cal. In combination with each burner of a connected system or series of gas-lamps, a mercury or liquid-containing chamber and gas inlet or outlet connected therewith in such manner that by displacement, or rise and fall of the mercury in



399,800. DYNAMO ELECTRIC MACHINE.

the chamber, or one part or compartment thereof, connection with the burner-passage is cut off or established.

124,800. Improvement in Telegraphic Recording Instruments; Thomas A. Edison of Newark, N. J., Assignor to himself and George Harrington, of Washington, D. C. A roller raised and lowered by the action of an electro-magnet, and acting to impress ink upon a strip of paper in dots and dashes.

124,868. Improvement in Electro-Magnetic Engines; William Wickersham, of Boston, Mass. The device and arrangement by which the polarity of each pole of one series (the revolving or fixed series) is reversed at the time of the nearest approach to one of the opposite series, the whole of the series in like manner being reversed at the same time.

PATENTS EXPIRED MARCH 26, 1889.

125,006. Electric Belt; J. E. Bazault, Paris, France. Patented March 26, 1872. A belt or other article for encircling the body or limbs, or any part thereof, filled or packed with oxide of iron or magnetic mineral reduced to a powder.

125,039. Apparatus for Steering Torpedo Boats, etc.; John G. Foster, Nashua, N. H. Patented March 26, 1872. The method of operating the steering devices of a torpedo boat by means of the direct application of electricity to the same.

125,078. Electro-Magnetic Apparatus; J. W. Powell, New York, N. Y. Patented March 26, 1872. This is practically a pole changer fixed in the handle of an electro magnetic device. It consists of a core of insulating material having two metallic plates at opposite points in its surface. The core is adapted to rotate between and in contact with two electrodes for the purpose of changing the terminals with respect to each other.

Copies of the specifications and drawings complete of any of the patents mentioned in this record—or of any other patents issued since 1886—can be had for 25 cents. Give the date and number of patent desired, and address The W. J. Johnston Co. Ltd., Potter Building, N. Y.

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